FLORA AND FAUNA OF THE COTTONWOOD WASH PROJECT AREA

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INTRODUCTION

A flora and fauna inventory of Magic Circle Cottonwood Wash Oil Shale Project area was conducted to provide biological baseline data to aid Synfuels Engineering and Development Company (SED) in obtaining a permit to mine and process oil shale. The surveys were conducted in accordance with guidelines provided by the Utah Department of Natural Resources, Division of Oil, Gas and Mining (DOGM) and Federal oil shale development (Federal Register 1973). The scope of the work includes:

1. Flora
   a. Vegetation map
   b. Plant species inventory and distribution
   c. Description of each vegetation type
   d. Survey for threatened or endangered plants
   e. Wildlife habitat description
   f. Revegetation guidelines
2. Fauna
   a. Species inventory with temporal and spatial distribution
   b. Survey for threatened or endangered animals
   c. Wildlife habitat survey and description
   d. Impacts on wildlife

Site Description

The Cottonwood Wash project area is located approximately 40 miles south of Vernal, Utah via U.S. Highway 40 and State Route 88. The project area includes 16 sections within T10S, R20E and 21E, in Uintah County,

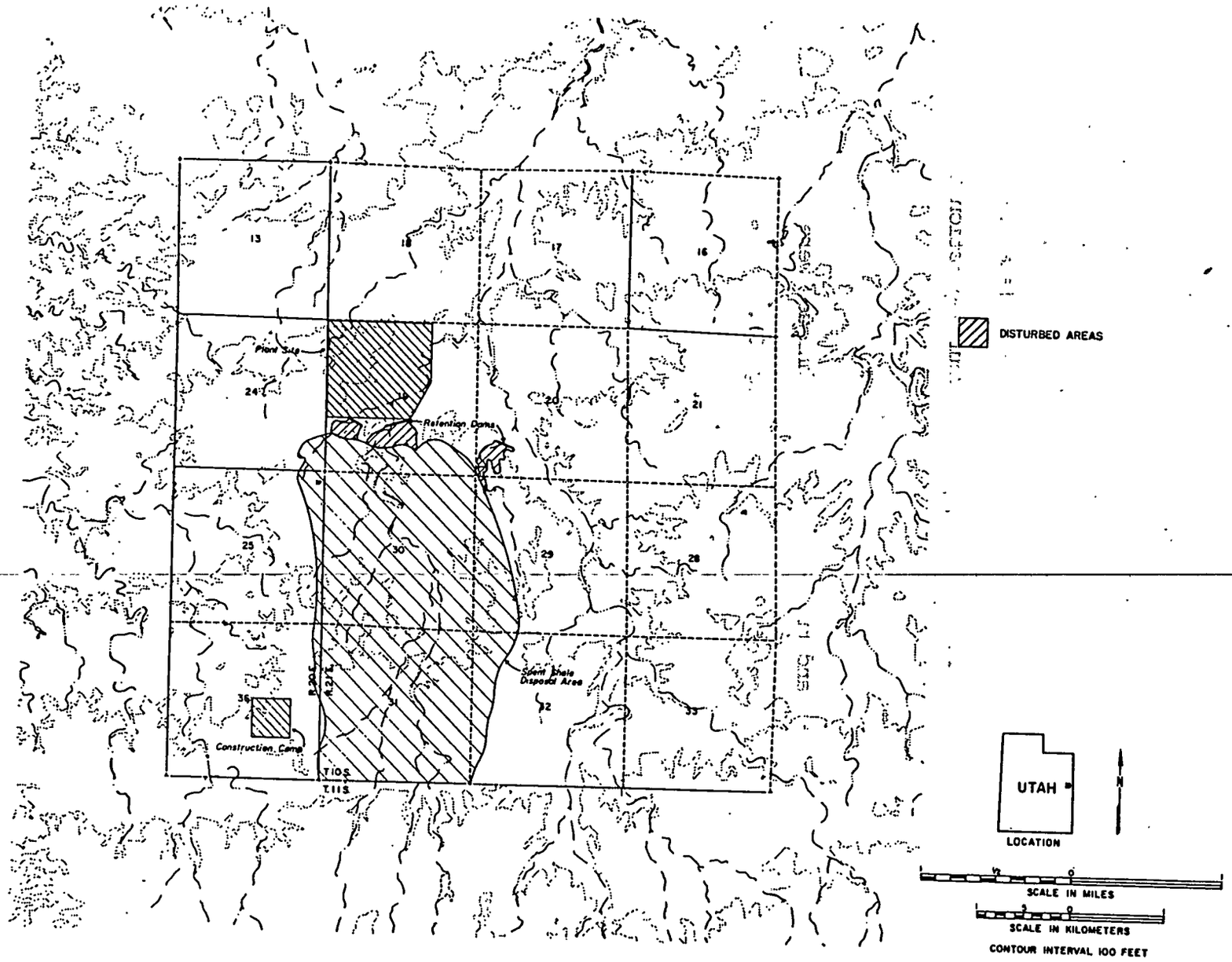
Utah. The biological survey included the 16 sections plus a 1.6 km (1 mile) perimeter (Fig. 1).

The Cottonwood Wash project area is on the Tavaputs Plateau within the Uinta Basin. Elevation varies from 1529 m (5,020 ft.) along Cottonwood Wash to 1657 m (5,440 ft.) on the steep hills and mesas. Cottonwood Wash, an ephemeral stream, divides the project area and empties into the White River. Annual precipitation varies from 20 to 23 cm (8 to 9 inches). Frost-free season is 115 to 125 days. The soils vary from clayey to sandy, and are shallow, and moderately to strongly developed over shale or sandstone bedrock. Erosion potential is moderate to severe (James P. Walsh & Assoc., Inc. 1982).

The primary land use is livestock grazing. Presently about 3,600 sheep utilize the Sand Wash Grazing Allotment from November 1 through April 30. Approximately 500 sheet graze on the project area. The vegetation of the project area supports about 975 AUM's (James P. Walsh & Assoc., Inc. 1982). The post-mining use of the area will be rangeland. Other present uses of the area include natural gas production, gilsonite mining, and recreation.

FLORA

A vegetal map was constructed of the study area to delineate the vegetation types. Sampling of the various vegetation types included plant cover, density, composition and frequency.



DISTURBED AREAS

Fig. 1. The flora and fauna surveys included 16 sections plus a 1.6 km perimeter.

METHODS

Vegetation Map

A vegetation map was constructed at a scale of 1:24,000. Aerial photography and field reconnaissance were used to delineate all vegetation types. Greasewood-sagebrush, shadscale-galleta grass, mat saltbush-galleta grass, and sagebrush were the four vegetation types identified.

Sampling Methods

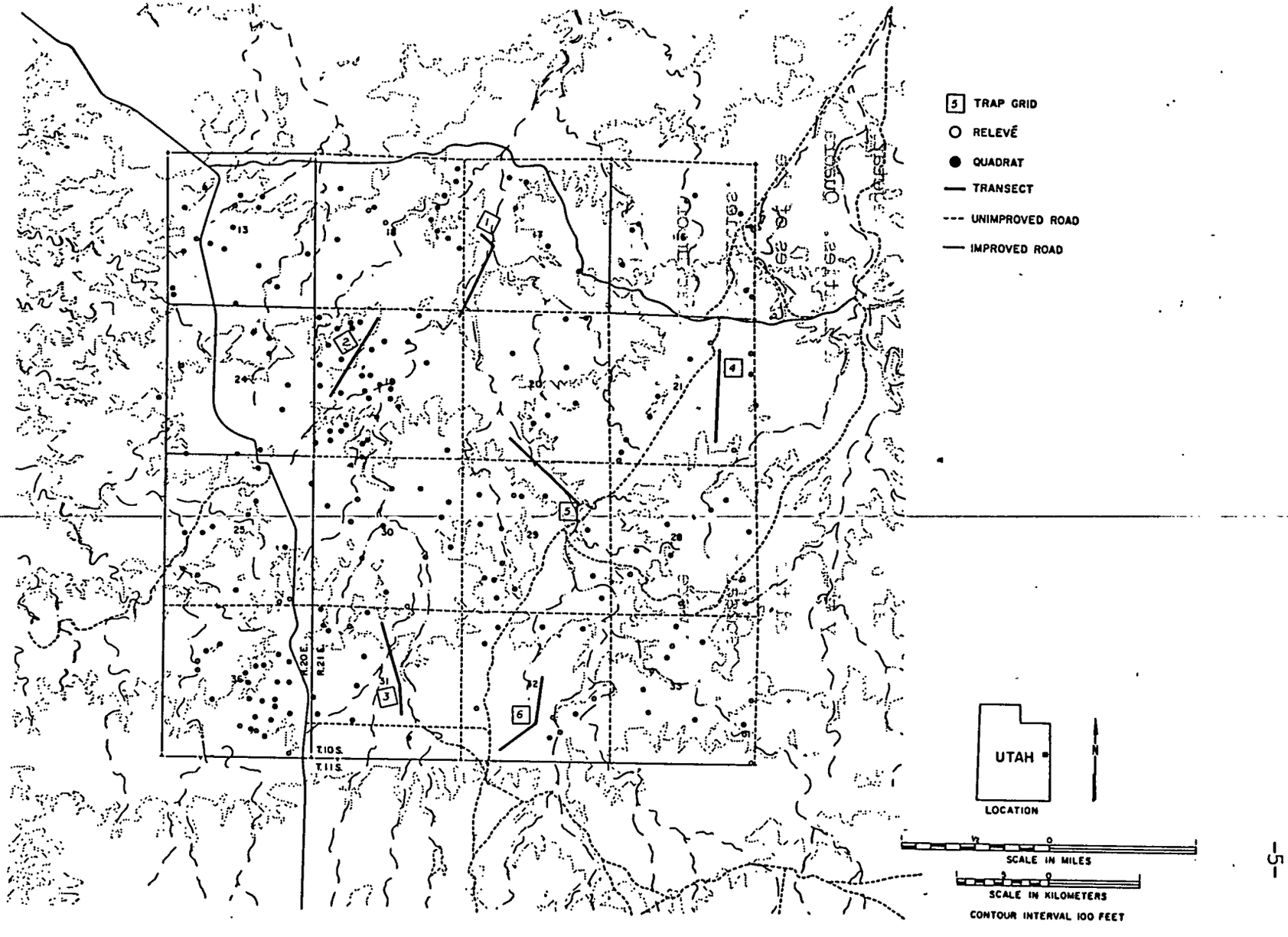
Releve, plot, and transect sampling techniques were utilized to describe the vegetation of the study area (Fig. 2).

Floristic Sampling

A plant species list was compiled in May 1981 prior to our inventory. Forty-eight vascular plant species were identified at that time. Thirty-seven additional species were added during the remainder of the field work. Also during the floristic sampling period and throughout the study, the project area was surveyed for threatened and endangered plant species. Threatened or endangered species were identified in the field, photographed, and confirmed by Dr. Stanley L. Welsh (Department of Botany and Range Science, Brigham Young University, Provo, Ut 84602). Nomenclature follows Welsh et al. (1981).

Releve

The releve sampling method described by Mueller-Dombois and Ellenberg (1974) was used to help delineate the vegetation types for the map. Releves



SAMPLING LOCATIONS

Fig. 2. Location of the releve, quadrat and transect sampling sites on the Cottonwood Wash project area.

were 5 x 5 m in size and randomly located throughout the study area. In each releve, all biennial and perennial species were recorded. In addition, percent cover by species was estimated. Releve sampling occurred October 23 to November 6, 1981. A total of 161 releves were examined.

Quadrat Sampling

Intensive vegetal sampling occurred within the vegetation types that will be disturbed by the proposed mining activities. Quadrats (2 x 2 m) were randomly located throughout the proposed sites of the man camp, processed shale disposal pile, and retorting facilities. Plant cover, frequency, and density were then determined so that importance values could be computed for each species (Brower and Zar 1977). Importance Values are the summation of relative cover, relative frequency, and relative density. Percent litter, rock, and bare ground were also estimated in each quadrat.

Total plant cover was used to determine the minimum sample size for each vegetation type. Statistical adequacy was determined by the following formula:

$$N_{min} = t^2 s^2 / (d\bar{x})^2$$

where: N_{min} = minimum sample size,

t = t-value for a 2-tailed test,

s = standard deviation,

d = allowable change in sample mean,

$\bar{x}$ = sample mean.

Sample size for plant cover was tested at the 80 percent confidence level ($t_{0.10,\infty}=1.282$) with a 10 percent error of the mean ($d=0.10$). Statistical Adequacy for Sampling was calculated after at least 20 quadrats were ob-

served. Table 1 gives the minimum sample size and observed sample size for each vegetation type with potential disturbance.

Plant cover by species was used to calculate the Shannon-Wiener Diversity Index:

$$H' = \Sigma P_i \log P_i$$

where: H' = diversity measure,

$P_i = N_i/N$,

N_i = cover value of species i,

N = the sum of all species cover values

Transect Sampling

Sampling was conducted along the six wildlife transects to characterize wildlife habitat. Sampling occurred from October 23 to November 6, 1981 and again from June 8 to 10, 1982.

For the first sampling period, 40 quadrats (2 x 2 m) were placed equal distance along a 1.0 km (0.6 miles) wildlife transect. Species composition, plant height, frequency, density, plant cover, bare ground, litter and rock were measured.

Only 20 quadrats were placed equal distance along the 1.0 km transects for the second sampling period. In addition to species composition, plant cover, density, litter, bare ground, and rock; herbaceous productivity was harvested. Above-ground biomass of annual and perennial forbs and grasses was harvested within a one-fourth square meter (0.25 m^2) circular plot placed in the lower left-hand corner of each quadrat. The harvested material was then oven-dried and weighed.

Table 1. Sample adequacy for total plant cover for the potentially disturbed vegetation types of the Cottonwood Wash project.

Vegetation Type	N_{min} [1]	$\bar{X}$ [2]	S.D. [3]	N_{obs} [4]
Shadscale-galleta grass	14	26.9	7.79	20
Greasewood-sagebrush	21	27.3	9.79	26
Mat saltbush-galleta grass	21	26.6	9.59	29

[1] minimum sample size
[2] sample mean
[3] standard deviation
[4] observed sample size

RESULTS

Plant Species and Vegetation Types

A vascular plant species list was prepared for the project area with 85 species being identified (Table 2). The majority of plants belong to the Composite, Goosefoot and Grass families.

The project area is located within a salt-desert shrub community (Butler and England 1979). However, mat saltbush-galleta grass, shadscale-galleta grass, greasewood-sagebrush and sagebrush vegetation types were identified within the permit area (Fig. 3). The boundary area was mapped as salt-desert shrub.

The distribution of these vegetation types appears to be controlled by soil texture, depth and water. The mat saltbush-galleta grass vegetation type occurs on the dry, shallow, clayey, rocky soils. The shadscale-galleta grass vegetation type occurs on moderate to deep, loamy to sandy soils. The greasewood-sagebrush vegetation type is located along drainages such as Cottonwood Wash with sandy, deep soils. The sagebrush vegetation type is located at the higher elevations of the permit area and probably receives more precipitation than the other vegetation types.

A fifth vegetation type, pond, was also identified. The pond vegetation type was not mapped because it is associated with 6 man-made ponds that occupy a total area of less than 0.4 ha (1.0 acre).

Mat saltbush-galleta grass

Mat saltbush-galleta grass is the dominant vegetation type occupying the northern three-fourths of the permit area (Fig. 4). Common shrubs are

Table 2. Floristic listing of vascular plants occurring within the Cottonwood Wash project area.

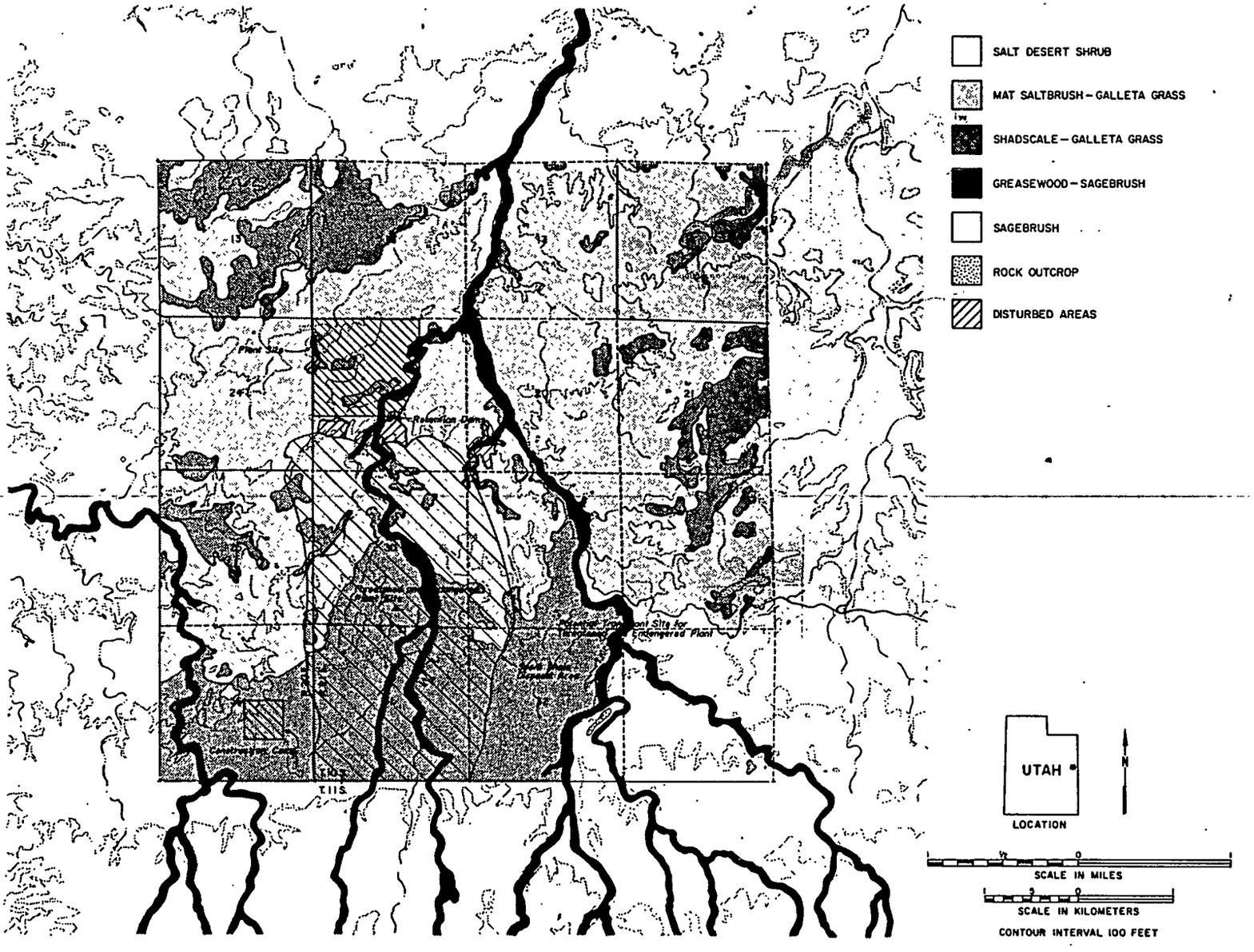
Family	Species	Common Name
Anacardiaceae		Cashew Family
	Rhus trilobata	Squawbush
Asteraceae		Composite Family
	Artemisia dracunculus	Tarragon
	A. frigida	Silver sage
	A. spinescens	Bud sage
	A. tridentata	Big sagebrush
	Brickellia microphylla	Rough littleleaf brickelbush
	Chaenactis douglasii	Douglas dustymaiden
	Chrysothamnus greenei	Green rabbitbrush
	C. nauseosus	Rubber rabbitbrush
	C. viscidiflorus	Low rabbitbrush
	Erigeron acris	Bitter fleabane
	E. pumilus	Low fleabane
	Grindelia squarrosa	Curlycup gumweed
	Helianthus annus	Common sunflower
	Iva axillaris	Povertyweed
	Machaeranthera canescens	Hoary machaeranthera
	Malacothrix torreyi	Torrey malacothrix
	Petradoria pumila	Rock goldenrod
	Platyschkuhria integrifolia	Oblongleaf bahia
	Taraxacum officinale	Common dandelion
	Tetradymia nuttallii	Nuttal horsebush
	T. spinosa	Spiny horsebush
	Tragopogan dubius	Yellow salsify
	Xanthium strumarium	Cocklebur
	Xanthocephalum sarothrae	Broome snakeweed
Boraginaceae		Borage Family
	Cryptantha flavoculata	Roughseed cryptantha
	C. humilis	Cryptantha
	C. kelseyana	Kelsey cryptantha
	Lappula occidentalis	Annual stickweed
Brassicaceae		Mustard Family
	Discurainia pinnata	Pinnate tansymustard
	Lepidium montanum	Mountain pepperweed
	Physaria acutifolia	Twinpod
	Sisymbrium altissimum	Tumblemustard
	Stanleya pinnata	Desert princesplum
Cactaceae		Cactus Family
	Opuntia polyacantha	Plains pricklypear
	Sclerocactus glaucus	Hookless fishhook cactus
Chenopodiaceae		Goosefoot Family
	Atriplex canescens	Fourwing saltbush
	A. confertifolia	Shadscale

Table 2. Continued.

Family	Species	Common Name
	A. corrugata	Mat saltbush
	A. cuneata	Cuneate saltbush
	A. patula	Fat-hen saltbush
	Ceratoides lanata	Winterfat
	Chenopodium album	Lambsquarters
	Grayia spinosa	Spiny hopsage
	Halogeton glomeratus	Halogeton
	Kochia americana	Green molly
	Salsola kali	Russian thistle
	Sarcobatus vermiculatus	Greasewood
	Suaeda torreyana	Torrey seepweed
Capparidaceae		Caper Family
	Cleome lutea	Yellow beeplant
Cyperaceae		Sedge Family
	Scirpus spp.	Bulrush
Ephedraceae		Ephedra Family
	Ephedra torreyana	Torrey ephedra
Euphorbiaceae		Spurge Family
	Euphorbia fendleri	Fendler euphorbia
Fabaceae		Pea Family
	Astragulis duchesnensis	Duschesne milkvetch
	A. geyeri	Geyer milkvetch
	Astragulis spp.	Locoweed
Loasaceae		Loasa Family
	Mentzelia albicaulis	Whitestem mentzelia
Hydrophyllaceae		Waterleaf Family
	Phacelia ivesiana	Scorpian weed
Malvaceae		Mallow Family
	Sphaeralcea coccinea	Scarlet globemallow
	S. parvifolia	Smallflower globemallow
Onagraceae		Evening Primrose Family
	Camissonia scapoidea	Barestem evening primrose
	Oenthera caespitosa	Tufted evening primrose
	O. trichocalyx	Tall evening primrose
Plantaginaceae		Plantain Family
	Plantago insularis	Desert Indianwheat
	P. patagonica	Wooly plantain
Poaceae		Grass Family
	Agropyron spicatum	Bluebunch wheatgrass
	Aristida purpurea	Purple threeawn
	Bromus tectorum	Cheatgrass
	Festuca octaflora	Sixweek fescue
	Hilaria jamesii	Galleta grass
	Hordeum jubatum	Foxtail barley
	Oryzopsis hymenoides	Indian ricegrass
	Poa sandbergii	Sandberg bluegrass
	Sitanion hystrix	Bottlebrush squirreltail
	Stipa comata	Needle-and-Thread grass
	Sporobolus cryptandrus	Sand dropseed

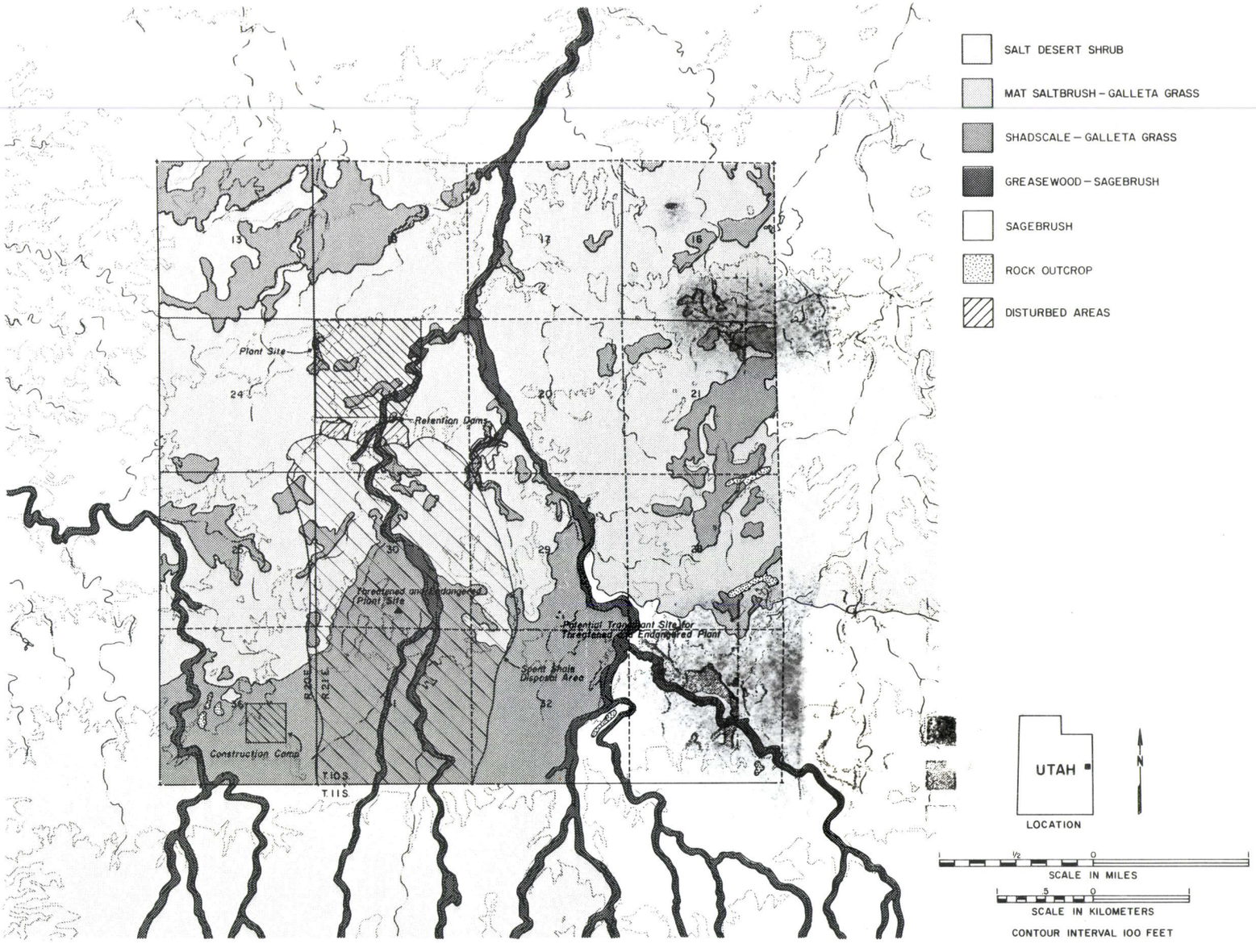
Table 2. Continued.

Family	Species	Common Name
Polemoniaceae		Phlox Family
	Gilia inconspicua	Shy gilia
	G. pumila	Dwarf gilia
	Leptodactylon pungens	Granite prickly gilia
Polygonaceae		Buchwheat Family
	Eriogonum inflatum	Desert trumpet eriogonum
	E. microthecum	Slenderbush eriogonum
Salicaceae		Willow Family
	Populus fremontii	Fremont cottonwood
Santalaceae		Sandalwood Family
	Comandra umbellata	Bastard toadflax
Tamaricaceae		Tamarix Family
	Tamarix pentandra	Saltcedar tamarisk
Typhaceae		Cattail Family
	Typha latifolia	Common cattail



VEGETATION MAP

Figure 3. Vegetation map of the Cottonwood Wash project area.



VEGETATION MAP

Fig. 4. The mat saltbush-galleta grass vegetation type mainly occupies the northern three-fourths of the Cottonwood Wash permit area (Photograph by Jerry R. Barker).

mat saltbush, shadscale, and cuneate saltbush (Tables 3 and 4). Important herbaceous plants include galleta grass, Douglas dustymaiden, cryptantha, desert Indianwheat, mountain pepperweed, and globemallow. Plant cover, based on the releve sampling, is about 14 percent (Table 4).

Shadscale-galleta grass

The shadscale-galleta grass vegetation type occupies mainly the southern one-fourth of the permit area (Fig. 5). Common shrubs are shadscale, big sagebrush, spiny hopsage, green molly, cuneate saltbush, rabbit rabbitbrush and spiny horsebrush (Tables 5 and 6). Galleta is the dominant grass of this vegetation type. Important forbs are low fleabane, hoary machaeranthera, mountain pepperweed, oblongleaf bahia, and globemallow. Plant cover is approximately 14 percent (Table 6).

Greasewood-sagebrush

The greasewood-sagebrush vegetation type is located along Cottonwood Wash and its associated drainages (Fig. 6). Important woody plants are greasewood, big sagebrush, rubber rabbitbrush, and spiny hopsage (Tables 7 and 8). Important forbs include globemallow and oblongleaf bahia. Galleta grass and Indian ricegrass are the important grasses. Both forbs and grasses are sparse in this vegetation type. Plant cover is approximately 28 percent (Table 8).

Sagebrush

The sagebrush vegetation type is found in the southeast corner of the permit area (Fig. 7). Big sagebrush, shadscale, greasewood, and

Table 3. Plant species by life-form that occur within the mat saltbush-galleta grass vegetation type.

Scientific Name	Common Name
Shrubs	
Artemisia spinescens	Bud sage
A. tridentata	Big sagebrush
Atriplex confertifolia	Shadscale
A. corrugata	Mat saltbush
A. cuneata	Cuneate saltbush
Brickellia microphylla	Rough littleleaf brickelbush
Ceratoides lanata	Winterfat
Chrysothamnus greenei	Green rabbitbrush
C. nauseosus	Rubber rabbitbrush
C. viscidiflorus	Low rabbitbrush
Eriogonum microthecum	Slenderbush eriogonum
Ephedra torreyana	Torrey ephedra
Grayia spinosa	Spiny hopsage
Kochia americana	Green molly
Leptodactylon pungens	Granite prickly gilia
Opuntia polyacantha	Plains pricklypear
Rhus trilobata	Squawbush
Sarcobatus vermiculatus	Greasewood
Tetradymia nuttallii	Nuttal horsebrush
T. spinosa	Spiny horsebrush
Xanthocephalum sarothrae	Broome snakeweed
Forbs	
Astragulus duchesnensis	Duschesne milkvetch
Astragulus spp.	Locoweed
Camissonia scapoidea	Barestem evening primrose
Chaenactis douglasii	Douglas dustymaiden
Cryptantha flavoculata	Roughseed cryptantha
Discurainia pinnata	Pinnate tansymustard
Erigerion acris	Bitter fleabane
E. pumilus	Low fleabane
Eriogonum inflatum	Desert trumpet eriogonum
Euphorbia fendleri	Fendler euphorbia
Gilia inconspicua	Shy gilia
G. pumila	Dwarf gilia
Halogeton glomeratus	Halogeton
Lappula occidentalis	Annual stickweed
Lepidium montanum	Mountain pepperweed
Machaeranthera canescens	Hoary machaeranthera
Malacothrix torreyi	Torrey malacothrix

Table 3. Continued

Scientific Name	Common Name
Forbs (cont.)	
Mentzelia albicaulis	Whitestem mentzelia
Oenthera caespitosa	Tufted evening primrose
O. trichocalyx	Tall evening primrose
Petradoria pumila	Rock goldenrod
Phacelia ivesiana	Scorpian weed
Physaria acutifolia	Twinpod
Plantago insularis	Desert Indianwheat
P. patagonica	Wooly plantain
Platyschkuhria integrifolia	Oblongleaf bahia
Salsola kali	Russian thistle
Sisymbrium altissimum	Tumblemustard
Sphaeralcea coccinea	Scarlet globemallow
S. parvifolia	Smallflower globemallow
Stanleya prinnata	Desert princesplum
Grasses	
Agropyron spicatum	Bluebunch wheatgrass
Aristida purpurea	Purple threeawn
Bromus tectorum	Cheatgrass
Festuca octaflora	Sixweek fescue
Hilaria jamesii	Galleta grass
Oryzopsis hymenoides	Indian ricegrass
Poa sandbergii	Sandberg bluegrass
Sitanion hystrix	Bottlebrush squirreltail

Table 4. Percent cover and frequency of plants within the mat saltbush-galleta grass vegetation type.

Species	Cover (%)	Frequency (%)
Aristida purpurea	<0.1	1.0
Artemisia spinescens	0.1	37.8
A. tridentata	0.1	5.2
Astragulus spp.	<0.1	2.1
Atriplex confertifolia	1.4	14.6
A. corrugata	4.7	20.8
A. cuneata	0.6	41.6
Brickellia microphylla	<0.1	1.0
Ceratoides lanata	<0.1	1.0
Chrysothamnus nauseosus	0.5	13.5
C. viscidiflorus	0.1	12.5
Cryptantha flavoculata	<0.1	1.0
Erigeron pumilus	<0.1	4.2
Eriogonum inflatum	<0.1	2.1
E. microthecum	<0.1	2.1
Grayia spinosa	0.1	3.1
Hilaria jamesii	2.2	89.6
Kochia americana	<0.1	26.0
Lepidium montanum	<0.1	27.1
Leptodactylon pungens	<0.1	6.3
Machaeranthera canescens	<0.1	15.6
Oryzopsis hymenoides	<0.1	14.6
Opuntia polyacantha	0.2	34.4
Platyschkuhria integrifolia	<0.1	24.0
Poa sandbergii	<0.1	3.1
Sarcobatus vermiculatus	0.6	14.6
Sitanion hystrix	<0.1	0.2
Spahaeralcea coccinea	<0.1	17.1
S. parvifolia	<0.1	3.1
Tetradymia nuttallii	0.1	6.3
T. spinosa	0.7	30.2
Xanthocephalum sarothrae	0.3	50.0

[1]The releve sampling method was used to obtain data.

Fig. 5. The shadscale-galleta grass vegetation type occupies the southern one-fourth of the Cottonwood Wash project area (Photography by Jerry R. Barker).

Table 5. Plant species by life-form that occur within the shadscale-galleta grass vegetation type.

Scientific Name	Common Name
Shrubs	
Artemisia spinescens	Bud sage
A. tridentata	Big sagebrush
Atriplex confertifolia	Shadscale
A. corregata	Mat saltbush
A. cuneata	Cuneate saltbush
Brickellia microphylla	Rough littleleaf brickelbush
Ceratoides lanata	Winterfat
Chrysothamnus greenei	Green rabbitbrush
C. nauseosus	Rubber rabbitbrush
C. viscidiflorus	Low rabbitbrush
Eriogonum microthecum	Slenderbush eriogonum
Ephedra torreyana	Torrey ephedra
Grayia spinosa	Spiny hopsage
Kochia americana	Green molly
Leptodactylon pungens	Granite prickly gilia
Opuntia polyacantha	Plains pricklypear
Sarcobatus vermiculatus	Greasewood
Sclerocactus glaucus	Hookless fishhook cactus
Tetradymia nuttallii	Nuttal horsebrush
T. spinosa	Spiny horsebrush
Xanthocephalum sarothrae	Broome snakeweed
Forbs	
Astragulus duchesnensis	Duschesne milkvetch
Astragulus spp.	Locoweed
Chaenactis douglasii	Douglas dustymaiden
Cryptantha flavoculata	Roughseed cryptantha
Discurainia pinnata	Pinnate tansymustard
Erigerion acris	Bitter fleabane
E. pumilus	Low fleabane
Eriogonum inflatum	Desert trumpet eriogonum
Euphorbia fendleri	Fendler euphorbia
Gilia inconspicua	Shy gilia
G. pumila	Dwarf gilia
Halogeton glomeratus	Halogeton
Lappula occidentals	Annual stickweed
Lepidium montanum	Mountain pepperweed
Machaeranthera canescens	Hoary machaeranthera
Mentzelia albicaulis	Whitestem mentzelia

Table 5. Continued.

Scientific Name	Common Name
Forbs (cont.)	
Oenthera caespitora	Tufted evening primrose
O. trichocalyx	Tall evening primrose
Petradoria pumila	Rock goldenrod
Physaria acutifolia	Desert Indianwheat
P. patagonica	Wooly plantain
Platyschkuhria integrifolia	Oblongleaf bahia
Salsola kali	Russian thistle
Sisymbrium altissimum	Tumblemustard
Sphaeralcea coccinea	Scarlet globemallow
S. parvifolia	Smallflower globemallow
Stanleya pinnata	Desert princesplum
Grasses	
Agropyron spicatum	Bluebunch wheatgrass
Aristida purpurea	Purple threeawn
Bromus tectorum	Cheatgrass
Festuca octaflora	Sixweek fescue
Hilaria jamesii	Galleta grass
Oryzopsis hymenoides	Indian ricegrass
Poa sandbergii	Sandberg bluegrass
Sitanion hystrix	Bottlebrush squirreltail

Table 6. Percent cover and frequency of plants within the shadscale-galleta grass vegetation type[1].

Species	Cover (%)	Frequency (%)
Astragulus sp.	<0.1	2.2
Artemisia spinescens	<0.1	15.6
A. tridentata	2.8	62.2
Atriplex confertifolia	1.5	80.0
A. corrugata	0.2	8.8
A. cuneata	<0.1	13.3
Brickellia microphylla	<0.1	2.2
Chrysothamnus nauseosus	1.1	22.2
C. viscidiflorus	0.2	20.0
Ephedra torreyana	<0.1	2.2
Erigeron pumilus	<0.1	6.7
Eriogonum microthecum	<0.1	11.1
Grayia spinosa	1.1	22.2
Hilaria jamesii	1.4	73.3
Kochia americana	<0.1	17.8
Lepidium montanum	<0.1	26.7
Leptodactylon pungens	<0.1	2.2
Machaeranthera canescens	<0.1	33.3
Oryzopsis hymenoides	<0.1	11.1
Opuntia polyacantha	<0.1	20.0
Petradoria pumila	<0.1	2.2
Platyschkuhria integrifolia	<0.1	13.3
Rhus trilobata	0.2	2.2
Sarcobatus vermiculatus	1.5	26.7
Sphaeralcea coccinea	<0.1	13.3
S. parvifolia	<0.1	8.8
Sitanion hystrix	<0.1	8.8
Tetradymia nuttallii	0.2	8.8
T. spinosa	1.8	46.6
Xanthocephalum sarthrae	0.3	33.3
Euphorbia fendleri	<0.1	2.2

[1]The releve sampling method was used to obtain data.

Fig. 6. The greasewood-sagebrush vegetation type is located along Cottonwood Wash and its associated drainages (Photograph by Jerry R. Barker).

Table 7. Plant species by life-form that occur within the greasewood-sagebrush vegetation type.

Scientific Name	Common Name
Trees	
Populus fremontii	Fremont cottonwood
Shrubs	
Artemisia spinescens	Bud sage
A. tridentata	Big sagebrush
Atriplex canescens	Fourwing saltbush
A. confertifolia	Shadscale
A. corrugata	Mat saltbush
A. cuneata	Cuneate saltbush
Chrysothamnus nauseosus	Rubber rabbitbrush
C. viscidiflorus	Low rabbitbrush
Grayia spinosa	Spiny hopsage
Opuntia polyacantha	Plains pricklypear
Sarcobatus vermiculatus	Greasewood
Tamarix pentandra	Saltcedar tamarisk
Tetradymia nuttallii	Nuttal horsebrush
T. spinosa	Spiny horsebrush
Xanthocephalum sarothrae	Broome snakeweed
Forbs	
Artemisia dracunculus	Tarragon
Astragulus geyeri	Geyer astragulus
Atriplex patula	Fat-hen saltbush
Camissonia scapoidea	Barestem evening primrose
Chaenactis douglasii	Douglas dustymaiden
Chenopodium alba	Lambsquarters
Cryptantha humalis	Cryptantha
C. kelseyana	Kelsey cryptantha
Cleome lutea	Yellow beeplant
Discurainia pinnata	Pinnate tansymustard
Euphorbia fendleri	Fendler euphorbia
Gilia inconspicua	Shy gilia
G. pumila	Dwarf gilia
Halogeton glomeratus	Halogeton
Lappula occidentals	Annual stickweed
Lepidium montanum	Mountain pepperweed
Machaeranthera canescens	Hoary machaeranthera
Malacothrix torreyi	Torrey malacothrix
Mentzelia albicaulis	Whitestem mentzelia
Oenthera caespitosa	Tufted evening primrose

Table 7. Continued.

Scientific Name	Common Name
Forbs (continued)	
O. trichocalyx	Tall evening primrose
Petradoria pumila	Rock goldenrod
Plantago insularis	Desert Indianwheat
P. patagonica	Wooly plantain
Platyschkuhria integrifolia	Oblongleaf bahia
Salsola kali	Russian thistle
Sisymbrium altissimum	Tumblemustard
Sphaeralcea coccinea	Scarlet globemallow
S. parvifolia	Smallflower globemallow
Stanleya pinnata	Desert princesplum
Suaeda torreyana	Torrey seepweed
Tragopogan dubius	Yellow salsify
Grasses	
Aristida purpurea	Purple threeawn
Bromus tectorum	Cheatgrass
Hilaria jamesii	Galleta grass
Poa sandbergii	Sandberg bluegrass
Sitanion hystrix	Bottlebrush squirreltail

Table 8. Percent cover and frequency of plants within the greasewood-sagebrush vegetation type.[1]

Species	Cover (%)	Frequency (%)
Artemisia dracunculus	<0.1	8.3
A. spinescens	<0.1	8.3
A. tridentata	4.3	58.3
Atriplex confertifolia	0.3	25.0
A. cuneata	<0.1	16.7
Chrysothamnus nauseosus	8.5	50.0
Grayia spinosa	1.8	41.7
Hilaria jamesii	<0.1	8.3
Machaeranthera canescens	0.1	8.3
Opuntia polyacantha	<0.1	8.3
Platyschkuhria integrifolia	<0.1	8.3
Sarcobatus vermiculatus	9.8	58.3
Tamarix pentandra	1.2	8.3
Tetradymia nuttallii	0.3	8.3
T. spinosa	1.0	25.0

[1]The releve' sampling method was used to obtain data.

Fig. 7. The sagebrush vegetation type is found in the southeast corner of the Cottonwood Wash permit area (Photograph by Nolan Preece).

broome snakeweed are the dominant woody plants (Tables 9 and 10). Galleta grass and Indian ricegrass are the common grass species. Other herbaceous plants include oblongleaf bahia, globemallow, and rock goldenrod. Plant cover is approximately 15 percent (Table 10).

Pond

This vegetation type is found associated with six man-made ponds (Fig. 8). The dominant woody plants are saltcedar tamarisk and greasewood (Table 11). These areas are highly disturbed by livestock. The pond vegetation type was not sampled.

Vegetation Types with Potential Disturbance

Mat saltbush-galleta grass, shadscale-galleta grass, and greasewood-sagebrush are the vegetation types with potential disturbance. Each of these vegetation types has been previously disturbed by livestock overgrazing, natural gas exploration and production, and gilsonite mining.

Mat saltbush-galleta grass

The area of potential disturbance is 2417 ha (5972.5 acres) which is 15.2 percent of the vegetation type. Bud sage, shadscale, mat saltbush, and galleta grass have the four highest importance values (Table 12). Mat saltbush is the dominant shrub with a cover of 7.4 percent and 124 plants per hectare (50 per acre). The dominant herbaceous species is galleta grass with a cover of 3.9 percent and 328 plants per hectare (131 per acre). The dominant perennial forbs are bitter fleabane, low fleabane, hoary machaeranthera, and scarlet globemallow. The importance of forbs

Table 9. Plant species by life form that occur within the sagebrush vegetation type.

Scientific Name	Common Name
Shrubs	
Artemisia spinescens	Bud sage
A. tridentata	Big sagebrush
Atriplex confertifolia	Shadscale
A. cuneata	Cuneate saltbush
Brickellia microphylla	Rough littleleaf brickelbush
Chrysothamnus greenei	Green rabbitbrush
C. viscidiflorus	Low rabbitbrush
Grayia spinosa	Spiny hopsage
Kochia americana	Green molly
Opuntia polyacantha	Plains pricklepear
Sarcobatus vermiculatus	Greasewood
Tetradymia spinosa	Spiny horsebrush
Xanthocephalum sarothrae	Broome snakeweed
Forbs	
Astragulus duchesnensis	Duschesne milkvetch
Chaenactis douglesii	Douglas dustymaiden
Comandra umbellata	Bastard toadflax
Discurainia pinnata	Pinnate tansymustard
Euphorbia fendleri	Fendler euphorbia
Gilia inconspicua	Shy gilia
G. pumila	Dwarf gilia
Halogeton glomeratus	Halogeton
Lappula occidentals	Annual stickweed
Lepidium montanum	Mountain pepperweed
Machaeranthera canescens	Hoary machaeranthera
Mentzelia albicaulis	Whitestem mentzelia
Physaria acutifolia	Twinpod
Plantago insularis	Desert Indianwheat
P. patagonica	Woody plantain
Platyschkuhria integrifolia	Oblongleaf bahia
Salsola kali	Russian thistle
Sisymbrium altissimum	Tumblemustard
Sphaeralcea coccinea	Scarlet globemallow
S. parvifolia	Smallflower globemallow
Stanleya pinnata	Desert princessplum
Grasses	
Aristida purpurea	Purple threeawn
Bromus tectorum	Cheatgrass
Hilaria jamesii	Galleta grass
Oryzopsis hymenoides	Indian ricegrass
Sitanion hystrix	Bottlebrush squirreltail

Table 10. Percent cover and frequency of plants within the sagebrush vegetation type.[1]

Species	Cover (%)	Frequency (%)
Aristida purpurea	<0.1	18.2
Artemisia tridentata	6.2	72.7
Astragulus sp.	<0.1	9.0
Atriplex confertifolia	2.4	63.6
A. cuneata	0.4	36.4
Chrysothamnus viscidiflorus	0.3	18.2
Eriogonum microthecum	<0.1	9.0
Hilaria jamesii	1.8	72.7
Kochia americana	<0.1	36.4
Oryzopsis hymenoides	<0.1	18.2
Opuntia polyacantha	<0.1	9.0
Petradoria pumila	0.1	9.0
Platyschkuhria integrifolia	<0.1	9.0
Sarcobatus vermiculatus	1.1	18.2
Sphaeralcea parvifolia	<0.1	9.0
Tetradymia nuttalii	<0.1	9.0
T. spinosa	0.3	18.2
Xanthocephalum sarothrae	0.9	72.7

[1]The releve' sampling method was used to obtain data.

Fig. 8. The pond vegetation type is associated with man-made ponds that are found within the Cottonwood Wash project area (Photograph by Nolan Preece).

Table 11. Plant species by life form that occur within the pond vegetation type.

Scientific Name	Common Name
Shrubs	
Sarcobatus vermiculatus	Greasewood
Tamarix pentandra	Saltcedar tamarisk
Forbs	
Grindelia squarrosa	Curlycup gumweed
Halogeton glomeratus	Halogeton
Helianthus annus	Common sunflower
Iva axillaris	Povertyweed
Taraxacum officinale	Common dandelion
Typha latifolia	Common cattail
Xanthium strumarium	Cocklebur
Grasslike plants	
Scirpus spp	Bulrush
Grasses	
Bromus tectorum	Cheatgrass
Hordeum jubatum	Foxtail barley

Table 12. Actual and relative cover, frequency and density of the perennial plant species found within the mat saltbush-galleta grass area of potential disturbance.

Species	Actual			Relative (%)			
	Cover (%)	Frequency (%)	Density (no/ha)	Cover	Frequency	Density	Importance Value
Artemisia spinescens	2.1	51.7	61	9.8	11.3	8.6	29.7
Atriplex confertifolia	3.0	55.1	33	13.9	12.1	4.7	30.7
Atriplex corrugata	7.4	72.4	124	34.5	15.8	17.3	67.6
Atriplex cuneata	0.3	13.8	18	1.4	2.6	3.0	7.0
Chrysothamnus viscidiflorus	0.2	6.9	3	1.2	1.5	0.4	3.1
Cryptantha flavoculata	<0.1	3.4	1	0.1	0.7	0.2	1.0
Erigeron acris	<0.1	3.4	8	0.1	0.7	1.2	2.0
Erigeron pumilus	0.2	17.2	9	1.0	3.7	1.3	6.0
Erigonum microthecum	0.2	6.9	11	1.2	1.5	1.5	4.2
Hilaria jamesii	3.9	62.1	328	18.0	13.6	46.2	77.8
Kochia americana	0.4	17.2	19	2.0	3.7	2.7	8.4
Lepidium montanum	0.1	3.4	1	0.6	0.7	0.2	1.5
Machaeranthera canescens	0.2	20.7	5	0.9	4.5	0.7	6.1
Opuntia polyacantha	0.3	17.2	7	1.5	3.7	1.0	6.2
Oryzopsis hymenoides	0.1	6.9	3	0.6	1.5	0.4	2.5
Sitanion hystrix	0.1	13.8	3	0.6	3.0	0.4	4.0
Sphaeralcea coccinea	0.6	44.8	26	3.1	9.8	3.7	16.6
Sphaeralcea parvifolia	<0.1	3.4	2	0.1	0.7	0.3	1.1
Tetradymia nuttallii	0.4	3.4	1	1.8	0.7	0.1	2.6
Tetradymia spinosa	0.4	6.9	1	1.8	1.5	0.2	3.5
Xanthocephalum sarothrae	1.0	24.1	37	4.7	5.3	5.2	15.2

in the vegetation depends on the time of year and weather conditions. Forbs provided significant cover during the early growing season of 1982 because of the wet spring.

Total plant cover is 24.7 percent with shrubs providing the majority of cover (Table 13). Rock cover is greater than in the other vegetation types due to the severe erosion potential. The plant diversity index is 2.24.

Productivity of the mat saltbush-galleta grass vegetation type was not measured. However, according to the soil survey report (James P. Walsh and Assoc., Inc. 1982), productivity varies from 56 to 336 kg/ha (50 to 300 pounds per acre) depending on range site and annual precipitation. Range condition is poor.

Shadscale-galleta grass

The area of potential disturbance is 1284.8 ha (3174.9 acres) which is 31.9 percent of the shadscale-galleta grass vegetation type. Shadscale, spiny hopsage and galleta grass have the three highest importance values (Table 14). Shadscale provides 5.4 percent cover and 35 plants per hectare (14 per acre). Plant cover and density for galleta grass is 3.9 percent and 278 plants per hectare (111 per acre), respectively. Important forbs are oblongleaf bahia, scarlet globemallow, and smallflower globemallow. The importance of forbs in the vegetation type depends on the season and weather conditions. Forbs provided significant cover during the early growing season of 1982 because of the wet spring.

Total plant cover is 26.9 percent with shrubs providing the majority of cover (Table 15). Cover of forbs and grasses is 3.3 and 3.9, percent respec-

Table 13. Percent plant cover, rock, litter and bare ground for the mat saltbush-galletagrass area of potential disturbance.

Parameter	Percent cover
Plant cover	24.7
Shrub	15.7
Forb	5.1
Grass	4.1
Rock	41.6
Litter	2.3
Bare ground	31.4

Table 14. Actual and relative cover, frequency, and density of the perennial plant species found within the shadscale-galleta grass area of potential disturbance.

Species	Actual			Relative (%)			
	Cover (%)	Frequency (%)	Density (no/ha)	Cover	Frequency	Density	Importance Value
Artemisia spinescens	0.4	15.0	6	1.8	4.3	1.2	7.3
Artemisia tridentata	0.7	5.0	1	3.1	1.4	0.2	4.7
Atriplex confertifolia	5.4	60.0	35	22.7	17.3	7.2	47.2
Atriplex corrugata	0.1	5.0	1	0.6	1.4	0.2	2.2
Atriplex cuneata	0.7	10.0	27	3.1	2.8	5.6	11.5
Chrysothamnus viscidiflorus	0.4	5.0	6	1.6	1.4	1.2	4.2
Eriogonum microthecum	<0.1	5.0	1	0.2	1.4	0.2	1.8
Grayia spinosa	7.2	35.0	15	30.2	10.1	3.1	43.4
Hilaria jamesii	3.9	75.0	278	16.4	21.7	57.7	95.8
Kochia americana	0.8	20.0	32	3.5	5.7	6.7	15.9
Opuntia polyacantha	0.4	20.0	10	1.6	7.2	2.0	10.8
Platyschkuhria integrifolia	0.2	5.0	12	0.8	1.4	2.5	4.7
Sarcobatus vermiculatus	1.2	15.0	3	5.2	4.3	0.7	10.2
Sphaeralcea coccinea	0.1	10.0	5	0.4	2.8	1.0	4.2
Sphaeralcea parvifolia	0.2	20.0	12	1.0	5.7	2.5	9.2
Tetradymia spinosa	1.1	15.0	6	4.7	4.3	1.2	10.2
Xanthocephalum sarothrae	0.6	20.0	27	2.5	5.7	5.6	13.8

Table 15. Percent plant cover, rock, litter, and bare ground for the shadscale-galletagrass area of potential disturbance.

Parameter	Percent Cover
Plant Cover	26.9
Shrub	19.0
Forb	3.3
Grass	3.9
Rock	7.0
Litter	3.2
Bare ground	62.8

tively. The plant diversity index for the area of potential disturbance is 2.07.

Productivity of the shadscale-galleta grass vegetation type was not measured. However, according to the soil survey report (James P. Walsh and Assoc., Inc. 1982) productivity varies from 168 to 1345 kg/ha (150 to 1200 pounds per acre) depending on range site and annual precipitation. Range condition is poor.

Greasewood-sagebrush

The area of potential disturbance is 411.7 ha (1017.4 acres) which is 14.0 percent of the greasewood-sagebrush vegetation type. Greasewood, big sagebrush, and galleta grass have the highest importance values in this vegetation type (Table 16). Greasewood has a cover of 6.8 percent and a density of 22 plants per hectare (9 per acre). Big sagebrush provides a cover of 7.0 percent and density of 43 plants per hectare (17 per acre). Within the permit area, only one Fremont cottonwood tree grows along Cottonwood Wash. Galleta grass is the most important herbaceous plant with a cover of 0.7 percent and density of 53 plants per hectare (21 per acre). Other herbaceous plants are Indian ricegrass and smallflower globemallow.

Total plant cover is 27.4 percent with shrubs providing the majority of cover (Table 17). Forb and grass cover is 3.8 and 0.8, percent respectively. The plant diversity index is 1.81.

Productivity of the greasewood-sagebrush vegetation type was not measured. However, productivity is estimated to be between 112 to 1120 kg/ha depending on annual precipitation and range site (James P. Walsh and Assoc., Inc. 1982). Range condition is poor.

Table 16. Actual and relative cover, frequency and density of the perennial plant species found within the greasewood-sagebrush area of potential disturbance.

Species	Actual			Relative (%)			
	Cover (%)	Frequency (%)	Density (no/ha)	Cover	Frequency	Density	Importance Value
Artemisia dracunculus	0.4	3.5	3	1.9	1.4	2.1	5.4
Artemisia spinescens	<0.1	7.1	1	0.3	2.9	1.0	4.2
Artemisia tridentata	7.0	50.0	43	32.4	20.5	26.2	79.1
Atriplex canescens	0.1	3.5	1	0.6	1.4	1.0	3.0
Atriplex confertifolia	3.0	57.1	33	3.6	7.3	3.7	14.6
Chrysothamnus nauseosus	1.6	10.7	3	7.3	4.4	2.1	13.8
Euphobia fendleri	<0.1	3.5	1	0.1	1.4	0.5	2.0
Grayia spinosa	2.7	21.4	7	12.4	8.8	4.2	25.4
Hilaria jamesii	0.7	14.3	53	3.6	5.8	32.0	41.4
Kochia americana	<0.1	7.1	1	0.3	2.9	1.0	4.2
Opuntia polyacantha	0.2	10.7	6	0.9	4.4	3.7	9.0
Oryzopsis hymenoides	<0.1	7.1	1	0.3	2.9	1.0	4.2
Sarcobatus vermiculatus	6.8	60.7	22	31.6	25.0	13.3	69.9
Sphaeralcea parvifolia	<0.1	3.6	1	0.1	1.4	1.0	2.5
Tetradymia spinosa	0.2	10.7	4	1.3	4.4	2.6	8.3
Xanthocephalum sarothrae	0.3	10.7	6	1.8	4.4	3.7	9.9

Table 17. Percent plant cover, rock, litter, and bare ground for the greasewood-sagebrush area of potential disturbance.

Parameter	Percent Cover
Plant Cover	27.4
Shrub	22.1
Forb	3.8
Grass	0.8
Rock	2.2
Litter	7.1
Bare ground	63.3

THREATENED OR ENDANGERED PLANTS

Threatened or endangered plant listings are synthetic. The threatened or endangered plant concept is defined by law (Endangered Species Act of 1978; as amended 1978) and thus subject to interpretation and reclassification (Welsh 1978; Welsh et al. 1981). Plants are classified as threatened or endangered because of a paucity in numbers. Plant rarity may result from a restricted habitat type or a disjunction in distribution (Welsh et al. 1981).

Threatened or endangered plants are presently classified into three categories (Neese and Smith 1982). Category 1 includes plants officially listed (Federal Register 1980). Category 2 plants are those deemed appropriate for Category 1 but are not yet officially listed. Category 3 are plants that are no longer being considered as threatened or endangered plants but are pending possible reevaluation.

Threatened or endangered plants occupy sites that have unique environmental characteristics. Such areas may include an exposed geologic formation, eroded knolls and unique soils (Cronquist et al. 1972). The Cottonwood Wash site and the Uinta Formation possess some of these properties. However, according to U.S. Fish and Wildlife Service personnel (personal communication, Larry England) few threatened or endangered plants are found on the Uinta Formation. They are usually found on the Green River Formation which is not exposed on the permit area.

Sclerocactus glaucus (K. Schum) L. Benson (Hookless fishhook cactus) is the only threatened or endangered plant found on the permit area (Figs. 9 and 10). The location of seven individuals in a spatial area of 2 x 25 m

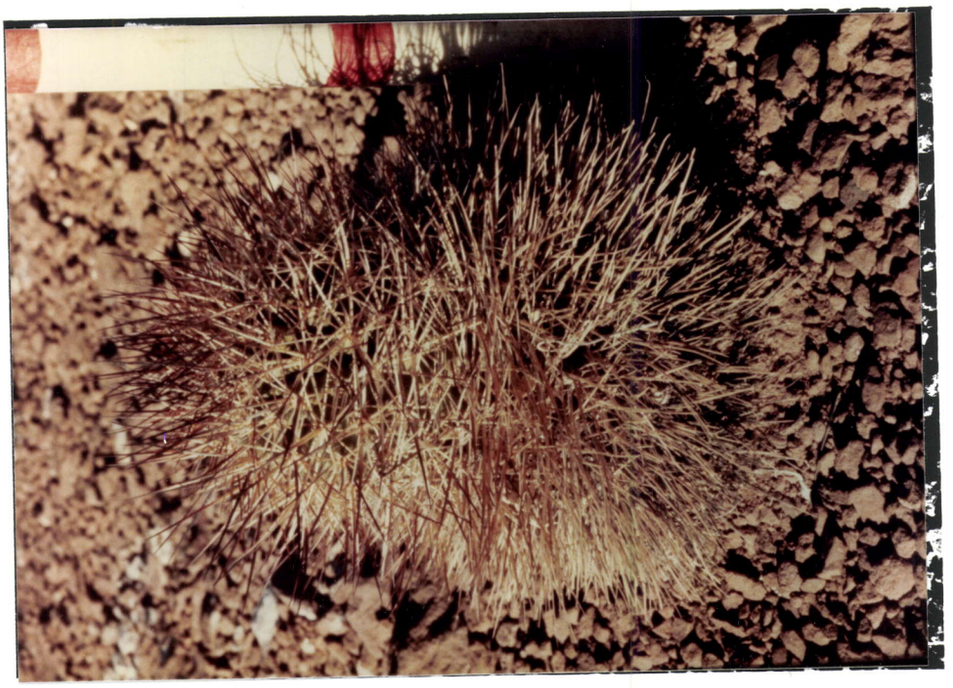


Fig. 9. Sclerocactus glaucus, a threatened and endangered plant, found growing on the Cottonwood Wash project area (Photograph by Nolan Preece).

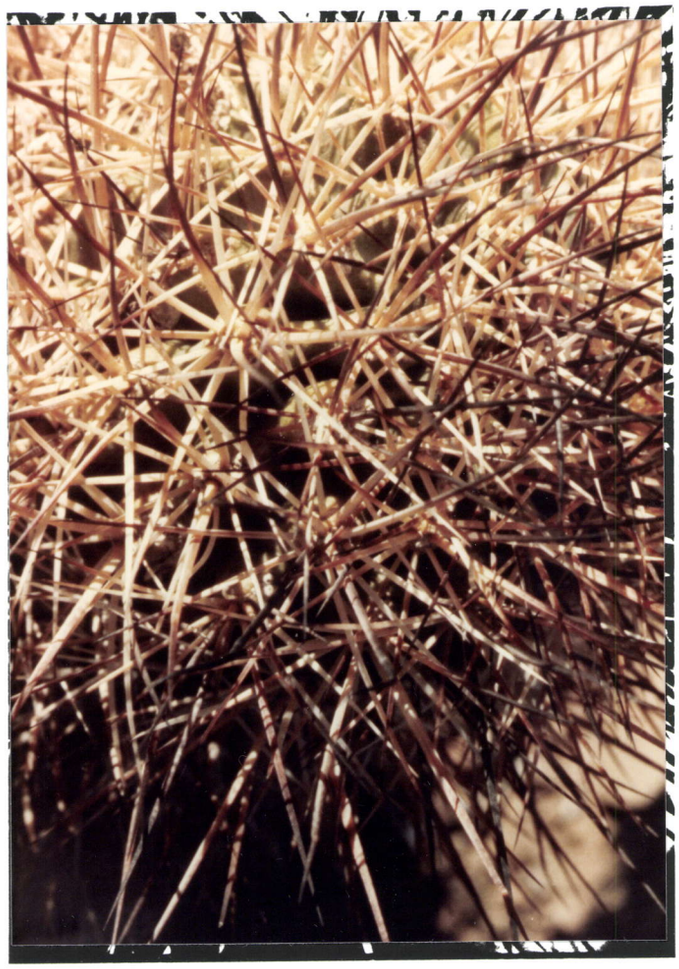


Fig. 10. Sclerocactus glaucus with its straight spines (Photograph by Nolan Preece).

is T10, R21E, Sec. 30, ¼SE, ¼SW (Fig. 9). Three mature plants (flowered in 1982), 3 juvenile plants (no sign of flowering), and 1 seedling were located. Confirmation of these plants as S. glaucus was from photographic colored slides by Dr. S. L. Welsh. During 1983, surveys will be conducted to identify other possible S. glaucus populations within and adjacent to the permit area. Known populations of S. glaucus occur in the Uintah and Duchesne Counties, Utah and Mesa and Delta Counties, Colorado along the Green and Colorado Rivers (Bureau of Land Management 1982).

These S. glaucus plants are growing within an area of potential disturbance. However, a site outside of the disturbed area has been located for transplanting the plants (Fig. 3). The location of the proposed transplanting site is Sec. 29, ¼SW. The proposed site is similar in soils, elevation, vegetation type, and aspect to the present location. During 1983, if needed, other potential transplanting sites will be identified.

Another species, located on the permit area, Astragalus duchesnensis Jones (Duschesne milkvetch) was listed as a threatened or endangered plant (Fig. 11, Welsh 1978). However, recently it has been removed from a Category 1 listing to Category 3 (S. L. Welsh, personal communication). This species was common throughout the Uinta Basin during the spring of 1982. Duschesne milkvetch was also common in the permit area.

No other threatened or endangered plants have been recorded within the study area. Neese and Smith (1982) give a listing of threatened or endangered plant species and their present legal status that occur within a 20 mile radius of the Cottonwood Wash project area.

Fig. 11. Astragalus duchesnensis found growing on the Cottonwood Wash project area (Photograph by Elizabeth Neese).

WILDLIFE HABITAT

Vegetation sampling along the wildlife transects was conducted to characterize wildlife habitat. Sampling occurred during the Fall of 1981 and Spring of 1982.

Fall

Aerial plant cover is an important parameter for wildlife habitat (Table 18). Transects 1 and 5 have the greatest plant cover at 16.8 and 19.8 percent, respectively. Plant cover along transects 2 and 4 is the least at 8.9 and 9.6 percent, respectively. Shrubs provide the majority of plant cover along each of the transects. Grass cover is greater than 2.5 percent in all transects except 1 and 5 which are in the mat saltbush-galleta grass vegetation type.

The architecture of plants influences wildlife distribution and abundance in salt-desert shrub communities (Table 19). Shrub size is more diverse within the greasewood-sagebrush vegetation type than in the other vegetation types. Thus, the greasewood-sagebrush vegetation type offers a more structural diverse habitat for wildlife than the other vegetation types.

Spring

Plant cover for the spring is consistently greater than for the fall (Table 20). This is due to the abundant precipitation during the winter and early spring. Shrubs provide the majority of cover, as they do all year. However, forb and grass cover increased dramatically as a result of the favorable growth conditions.

Table 18. Percent plant cover, rock, litter and bare ground along the wildlife transects during the fall, 1981.

Parameter	Transect 1[a]	2[b]	3[c]	4[b]	5[a]	6[c]
Plant cover	16.8	8.9	14.0	9.6	19.8	12.4
Shrub	16.1	6.7	10.9	5.9	18.2	8.4
Forb	0.8	0.5	0.4	0.7	0.9	0.9
Grass	0.1	2.5	3.2	3.6	0.6	3.9
Rock	9.7	61.9	25.4	15.8	22.8	27.5
Litter	13.7	4.3	7.1	3.4	6.6	6.5
Bare ground	59.6	24.8	53.3	71.1	50.7	53.4

[a]Greasewood-sagebrush vegetation type

[b]Mat saltbush-galleta grass vegetation type

[c]Shadscale-galleta grass vegetation type

Table 19. Mean plant height, cover and volume of shrubs along the wildlife transects.

Transect	Species	Height (m)	Cover (m^2)	Volume (m^3)
1	Artemisia tridentata	0.5	0.2	0.1
	Atriplex canescens	1.0	1.0	0.8
	Chrysothamnus nauseosus	0.5	0.4	0.2
	Grayia spinosa	0.9	1.1	0.7
	Sarcobatus vermiculatus	0.9	0.7	0.5
	Xanthocephalum sarothrae	0.3	0.1	0.1
	Grand Mean	0.7	0.6	0.4
	Dead Plants	0.6	0.3	0.2
2	Artemisia spinescens	0.08	0.02	0.002
	Atriplex confertifolia	0.17	0.06	0.008
	A. corrugata	0.06	0.04	0.002
	A. cuneata	0.08	0.01	0.001
	Chrysothamnus viscidiflorus	0.20	0.08	0.021
	Leptodactylon pungens	0.12	0.04	0.004
	Xanthocephalum sarothrae	0.16	0.02	0.004
	Grand Mean	0.12	0.04	0.006
	Dead Plants	0.12	0.04	0.005
3	Artemisia spinescens	0.12	0.02	0.002
	A. tridentata	0.29	0.11	0.040
	Atriplex confertifolia	0.26	0.09	0.023
	Chrysothamnus viscidiflorus	0.27	0.05	0.009
	Eriogonum microthecum	0.06	0.01	0.001
	Grayia spinosa	0.47	0.32	0.109
	Kochia americana	0.10	0.01	0.001
	Xanthocephalum sarothrae	0.14	0.08	0.026
	Grand Mean	0.21	0.09	0.026
	Dead Plants	0.13	0.03	0.003
4	Artemisia spinescens	0.19	0.05	0.006
	Atriplex confertifolia	0.28	0.11	0.025
	A. cuneata	0.06	0.01	0.001
	Chrysothamnus nauseosus	0.62	0.22	0.089
	C. viscidiflorus	0.26	0.12	0.036
	Grayia spinosa	0.55	0.38	0.177
	Kochia americana	0.09	0.01	0.001
	Sarcobatus vermiculatus	0.61	0.31	0.189
	Tetradymia spinosa	0.35	0.14	0.046

Table 19. Continued.

Transect	Species	Height (m)	Cover (m^2)	Volume (m^3)
	Xanthocephalum sarothrae	0.16	0.02	0.004
	Grand Mean	0.32	0.14	0.057
	Dead Plants	0.18	0.11	0.016
5	Artemisia tridentata	0.6	0.10	0.200
	Atriplex canescens	0.8	0.30	0.200
	A. confertifolia	0.2	0.10	0.010
	Chrysothamnus nauseosus	0.7	0.60	0.400
	Grayia spinosa	0.4	0.10	0.010
	Kochia americana	0.1	0.01	.001
	Sarcobatus vermiculatus	1.0	1.00	0.800
	Tetradymia spinosa	0.3	0.10	0.002
	Xanthocephalum sarothrae	0.1	0.01	0.001
	Grand Mean	0.5	0.30	0.200
	Dead Plants	0.9	0.50	0.400
6	Artemisia spinescens	0.17	0.02	0.003
	A. tridentata	0.30	0.11	0.032
	Atriplex confertifolia	0.25	0.09	0.020
	A. cuneata	0.06	0.03	0.001
	Chrysothamnus viscidiflorus	0.27	0.06	0.012
	Eriogonum microthecum	0.10	0.01	0.001
	Kochia americana	0.08	0.01	0.001
	Tetradymia nuttallii	0.48	0.30	0.102
	T. spinosa	0.41	0.16	0.059
	Grand Mean	0.24	0.09	0.026
	Dead Plants	0.15	0.06	0.008

Table 20. Percent plant cover, rock, litter, and bare ground occurring along the wildlife transects during the spring, 1982.

Parameter	Transect 1[a]	2[b]	3[c]	4[b]	5[a]	6[c]
Plant cover	30.5	33.6	51.0	50.4	41.8	57.2
Shrub	24.4	14.8	34.8	23.9	17.4	37.1
Forb	11.4	13.6	20.0	13.3	26.8	25.8
Grass	0.1	6.8	5.3	14.1	0	13.9
Rock	11.8	39.1	17.4	6.4	4.8	4.4
Litter	10.2	4.5	8.6	3.9	11.6	7.3
Bare ground	47.2	22.8	29.2	39.3	41.7	31.1

[a]Greasewood-sagebrush vegetation type

[b]Mat saltbush-galleta grass vegetation type

[c]Shadscale-galleta grass vegetation type

Herbaceous production was considerable during the spring (Table 21). Herbaceous production along transect 6 was the highest and least along transect 1.

REVEGETATION GUIDELINES

Critical to the mining process is the revegetation of disturbed areas. Whether the revegetation is short term (1 to 3 years) or long term (longer than 3 years) proper steps must be followed to ensure its success. This section is not designed to be a state-of-the-art review of the subject, but only to acquaint the non-revegetation specialist with the main principles.

Plant Selection

The first step in any revegetation program is the selection of plant species. Plant species must be selected that are adapted to the environmental constraints of the planting site (Van Epps and McKell 1978). Other considerations include forage value, erosion control, wildlife habitat, post-mining use, etc. Native plant species are usually preferred because of their adaption to the ecological conditions of the area in which they are growing. The baseline study should be a source of help in selecting plants for revegetating the disturbed sites and processed shale pile.

Introduced species should not be overlooked if they are adapted to the site. Many introduced plants have been tested and found suitable for mined-land reclamation on arid rangelands.

There should be a mix in plant species and life forms to provide ecological diversity (Plummer et al. 1968). Mixture of plant species provide

Table 21. Herbaceous plant production (kg/ha) along the wildlife transects during the spring, 1982.

	Annual		Perennial		
Transect	Forb	Grass	Forb	Grass	Total
1	28.0	0	0	0	28.0
2	52.0	0	12.0	52.0	116.0
3	100.0	0	20.0	4.0	124.0
4	68.0	76.0	1.6	40.0	185.6
5	132.0	0	0.2	0.4	132.6
6	104.0	20.0	12.0	92.0	228.0

better wildlife habitat and forage availability. Numerous plant species may exploit the various microhabitats of the site better than one or two species. In addition, a species mix will provide better erosion control. Deep-rooted plants help prevent mass soil slippage, a critical factor on steep slopes. Shallow, wide-spreading root systems characteristic of many grasses and forbs enhance soil surface stability (Institute for Land Rehabilitation 1979).

In selecting plants for specific sites, care should be given to seed source. Genetic variation among ecotypes and populations of the same plant species can be tremendous (Plummer 1975). An excellent source of seed and vegetation material for plant propagation is the local vegetal communities. Special attention should be given to plants growing on exposed subsoils or other unusual geologic formation. The kinds of plants growing under stressful environmental conditions can indicate a useful seed source to revegetate problem areas.

Plant Materials

Seeds, container-grown plants, and bare-root stock are ways to revegetate a site. Proper selection depends on the environmental conditions of the soil, plant material availability, and cost.

Seeds

Seeds of many native and introduced plant species are available commercially from collectors and seed companies. When purchasing seed, care should be given to the source of the seed and variety. However, seed from adjacent non-disturbed plant populations is an excellent source and should not be overlooked. Collectors can be contracted to collect the seeds.

Seeds are usually inexpensive and should be used when environmental conditions are proper for germination and seedling establishment. Seeds usually require from 14 to 21 days of warm moist soil to germinate and become established. Seedings in areas that receive less than 30 cm (12 inches) of rain usually result in failure (Institute for Land Rehabilitation 1979).

Container-grown plants

Container-grown plants are available commercially. Such companies produce seedlings that are properly prepared for transplanting. However, costs are usually more than for seeds of the same species.

Container-grown plants are recommended for revegetating harsh sites, areas with erratic or low precipitation or on sites with potential erosion problems. Plants grown in containers usually are fast growing after transplanting. The use of container-grown plants can extend the planting season beyond that which is safe for seeding.

The disadvantage of container grown plants is that some species are difficult to cultivate. Container plants are heavy and bulky. Also, proper care is needed to ensure survival when transplanting them to the field

Bare-root stock

Bare-root stock is grown in plant beds for 1 to 2 years. When the plants are large enough and dormant, they are dug up and packaged in crates with moist peat moss. Bare-root stock is usually available from the same sources that provide container-grown plants.

Bare-root plants provide fast growing cover on critical erosion sites. This type of planting material is less expensive than container-grown plants. However, bare-root stock usually has a lower percent survival than container-grown plants (Institute for Land Rehabilitation 1979). Also, bare-root stock must be planted when the soil will be wet for 2 to 3 weeks.

Site Preparation

An important step in any revegetation project is site preparation. Any factor that may prevent successful plant establishment should be determined and mitigated before planting occurs (Institute for Land Rehabilitation 1979).

Surface contouring and shaping may enhance plant establishment and growth. The degree of surface slope and exposure are important factors affecting erosion control and plant growth. The avoidance of long, steep slopes is essential for erosion control. However, small trénches and pockets in the soil can collect water to enhance plant growth and reduce the erosion potential (Branson et al. 1972, Wright et al. 1974).

The physical and chemical properties of the soil must be conducive to plant establishment and root growth. The soil should be firm but not compacted, well pulverized on top, not cloddy, and free from weedy plant competition (Plummer et al. 1968). Plant nutrients such as nitrogen, phospherus and potassium should be suitable for plant growth. Extreme soil conditions such as high pH, salinity, and toxic substances may need to be ameliorated. To prepare a proper plant growth medium, cultural practices such as fertilizing, mulching, soil ripping and furrowing, and

weed control may be necessary. However, potential site problems and appropriate cultural treatments can be identified through soil analysis, small plot tests, and pilot models.

The irrigation of planted areas is a question that must be answered before planting occurs. Supplemental water does increase plant growth and survival. However, plants may become water dependent and die when irrigation ceases. Plant death results because plants are not adapted physiologically or anatomically to drier conditions. If irrigation is deemed necessary, it should occur only for initial plant establishment at a rate that will allow deep water percolation and avoid erosion.

Another alternative to irrigating is water harvesting. This practice occurs when the soil surface is designed to allow the accumulation of natural precipitation around plants (Intermountain Forest and Range Experiment Station 1979). Several methods can be used to collect water. An area of several feet long and wide can be compacted, or chemically treated to prevent water infiltration with a catchment basin at the bottom is one method. Other methods include surface pitting, contouring, and gouging. In fact, any treatment which collects water and directs it to plants can be used.

Time of Planting

Planting time, in general, should coincide with the longest precipitation period during the year. Of course, the planting time may vary with type of planting material, soil, plant species, and cultural treatments. An examination of meteorological data is helpful to determine the best planting time for a given area.

In the Intermountain area successful plantings can usually be obtained in both the spring and fall depending on the plant material used. Many seeds require a stratification period. Thus, a fall planting would be best. Container-grown plants can be planted in late spring provided that they are "watered-in." Bare-root stock should be planted in early spring for optimum results. However, one problem that may reduce survival of container plants and bare-root stock during the fall is frost heaving if roots do not have time to extend into the soil before freezing occurs.

Post Planting Management

The final step in a revegetation plan is the continued management of the area. Grazing of young seedlings will reduce plant survival and growth. Weedy plants will deplete soil water and nutrients if not controlled. Emergency irrigation of plants may be necessary under extreme drought conditions (Institute for Land Rehabilitation 1979).

Fencing is probably the best method to deter livestock and big game animals. However, fences are usually worthless in preventing rodent and rabbit damage. In some areas repellents may be beneficial in preventing rodent and rabbit damage. Probably the best method to mitigate the grazing damage to plants is to transplant large seedlings with multiple branches and stems, revegetate large areas, and include several unpalatable species in the planting mix (Institute for Land Rehabilitation 1979).

Weedy plants can be controlled with a herbicide. However, care should be used not to kill the desirable plants also. Mechanical tillage among desirable plants is also beneficial in reducing weedy plant competition. In areas where machines cannot operate, hand removal of weeds may be necessary.

During extreme drought conditions, emergency irrigation may be necessary. Sprinkler irrigation systems may be the most effective method if a water source is available. However, hand-watering of plants may improve plant survival under extreme conditions.

REVEGETATION OF COTTONWOOD WASH PROJECT AREA

Short-term Revegetation

Areas that need to be revegetated but will again be disturbed in 1 to 3 years are considered short-term projects. Such areas may include topsoil stock piles, subsurface soil stock piles, right-of-ways, and maintenance areas.

The primary goal of short-term revegetation is to achieve soil surface stability and prevent wind and water erosion. Another objective is to maintain viable soil fauna and flora in the stock-piled soils. Finally, disturbed and stock-piled soils will maintain a viable seed reserve if revegetated.

Plants should be selected that germinate readily and become established quickly. If the vegetation cover is to last for only 1 year annual species will be satisfactory. Perennials should be included in the plant mixture if a longer time period is required. Table 22 lists several native and adapted introduced plant species that should be adequate for short-term revegetation on the Cottonwood Wash project area.

Due to the fact that all the species are grasses and forbs and to keep costs low, seeding will probably be the chosen revegetation method. The seeding rate will depend on whether the seed is broadcast or direct seeded. If the seed is broadcast 22 to 27 kg/ha (20 to 24 pounds per acre)

Table 22. Plant species suitable for short-term revegetation at the Cottonwood Wash project area.

Species	Common Name
Agropyron desertorum	Standard crested wheatgrass
A. riparium	Streambank wheatgrass
A. smithii	Western wheatgrass
Elymus cinerus	Basin wildrye
E. junceus	Russian wildrye
Lolium multiflorum	Annual ryegrass
Medicago sativa	Ranger alfalfa
Melilotus officinalis	Yellow sweetclover
Oryzopsis hymenoides	Indian ricegrass
Plantago insulares	Desert Indianwheat
Secale cereale	Cereal rye
S. montanum	Mountain rye
Sporobolus cryptandrus	Sand dropseed

will be needed. If the seed is direct seeded about 13 to 17 kg/ha (12 to 15 pounds per acre) is needed. Direct seeding is usually better than broadcasting. Therefore, if at all possible, broadcast seed should be covered with soil by racking or railing.

Late fall or early spring is the best time for seeding at Cottonwood Wash. Seeding should occur at a time when soils will be moist for several weeks. Sufficient time is needed to allow for seed germination and seedling establishment before the soil becomes dry. Irrigating seeded areas until seedlings are established will increase the rate of plant growth.

Long-term Revegetation

Long-term revegetation includes areas that require stabilizing for periods longer than 3 years. Long-term revegetation is not necessarily permanent revegetation. However, in many cases the two are the same and thus may be treated similarly.

The primary goals of long-term revegetation are to minimize soil and wind erosion, provide plant cover and animal forage, and be compatable with the post-mining use objective.

Plants that are selected to revegetate disturbed sites within the Cottonwood Wash Project should be drought, salinity, and grazing tolerant. A planting mixture should be selected that is compatable with existing non-disturbed vegetation and able to occupy the microhabitats of the site. Perennial plants are recommended because they provide ground cover during dormant periods.

A planting mix is recommended for each vegetation type with areas of potential disturbance (Tables 23, 24 and 25). The planting mix consists

Table 23. Selected plant species for long-term revegetation within the mat-saltbush-galletagrass vegetation type at the Cottonwood Wash project area.

Species	Common Name
Shrubs	
Artemisia spinescens	Bud sage
Atriplex confertifolia	Shadscale
A. corrugata	Mat saltbush
A. cuneata	Cuneate saltbush
Ceratoides lanata	Winterfat
Chrysothamnus viscidiflorus	Low rabbitbrush
Kochia americana	Green molly
Opuntia polyacantha	Plains pricklypear
Forbs	
Cryptantha flavoculata	Roughseed cryptantha
Lepidium montanum	Mountain pepperweed
Machaeranthera canescens	Hoary macheranthera
Malacothrix torreyi	Torrey malacothrix
Petradoria pumila	Rock goldenrod
Plantago insularis	Desert Indianwheat
Sphaeralcea coccinea	Scarlet globemallow
S. parvifolia	Smallflower globemallow
Grasses	
Hilaria jamesii	Galletagrass
Oryzopsis hymenoides	Indian ricegrass
Sitanion hystrix	Bottlebrush squirreltail

Table 24. Selected plant species for long-term revegetation within the shadscale-galletagrass vegetation type at the Cottonwood Wash project area.

Species	Common Name
Shrubs	
Artemisia spinescens	Bud sage
A. tridentata wyomingensis	Wyoming big sagebrush
Atriplex confertifolia	Shadscale
A. cuneata	Cuneate saltbush
Chrysothamnus viscidiflorus	Low rabbitbrush
Ephedra torreyana	Torrey ephedra
Grayia spinosa	Spiny hopsage
Kochia americana	Green molly
Opuntia polyacantha	Plains pricklypear
Sarcobatus vermiculatus	Greasewood
Forbs	
Cryptantha flavoculata	Roughseed cryptantha
Hedysarum boreale	Utah sweetvetch
Lepidium montanum	Mountain pepperweed
Linum lewisii	Lewis flax
Machaeranthera canescens	Hoary machaeranthera
Petrodoria pumila	Rock goldenrod
Platyschkuhria integrifolia	Oblongleaf bahia
Sphaeralcea coccinea	Scarlet globemallow
S. parvifolia	Smallflower globemallow
Grasses	
Agropyron spicatum	Bluebunch wheatgrass
Hilaria jamesii	Galletagrass
Oryzopsis hymenoides	Indian ricegrass
Sitanion hystrix	Bottlebrush squirreltail
Sporobolus crytandrus	Sand dropseed
Stipa comata	Needle-and-Thread grass

Table 25. Selected plant species for long-term revegetation within the greasewood-sagebrush vegetation type at the Cottonwood Wash project area.

Species	Common Name
Shrubs	
Artemisia tridentata tridentata	Basin big sagebrush
Atriplex canescens	Fourwing saltbush
A. confertifolia	Shadscale
Chrysothamnus nauseosus	Rubber rabbitbrush
Grayia spinosa	Spiny hopsage
Sarcobatus vermiculatus	Greasewood
Forbs	
Hedysarum boreale	Utah sweetvetch
Linum lewisii	Lewis flax
Plantago insulares	Desert Indianwheat
Platyschkuhria integrifolia	Oblongleaf bahia
Spaheralcea coccinea	Scarlet globemallow
S. parvifolia	Smallflower globemallow
Grasses	
Hilaria jamesii	Galletagrass
Oryzopsis hymenoides	Indian ricegrass
Sitanion hystrix	Bottlebrush squirreltail
Stipa comata	Needle-and-Thread grass
Sporobolus cryptandrus	Sand dropseed

of shrubs, forbs, and grasses that are common to each vegetation type.

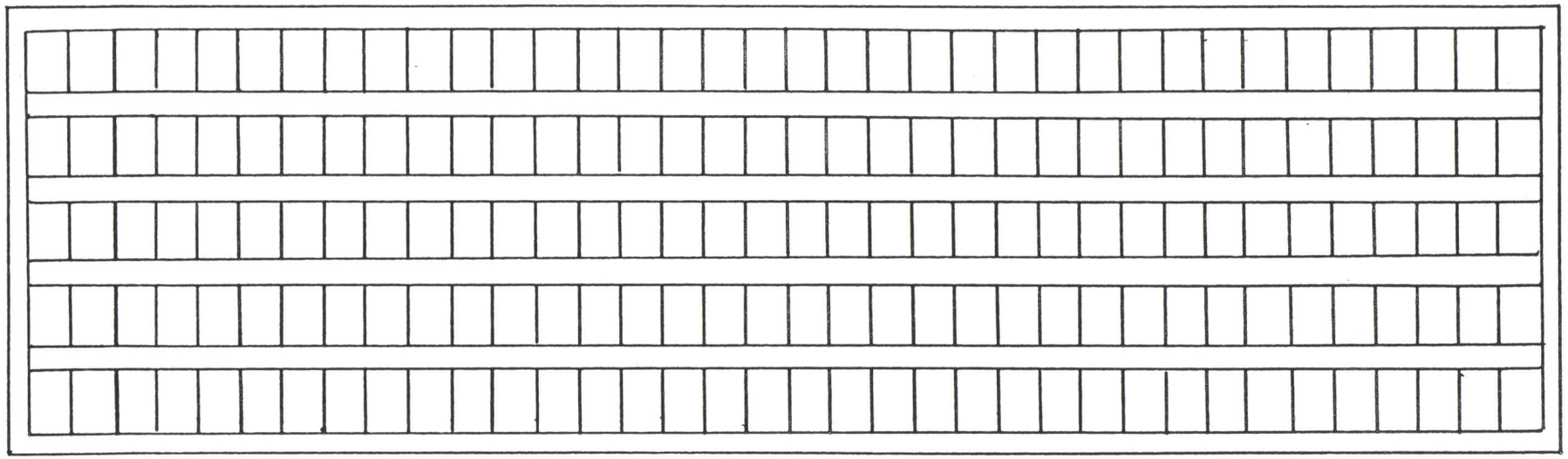
Container-grown plants are the recommended choice for plant establishment. Container-grown plants can be planted during the fall and spring when soils are moist. However, they can also be planted in late spring if they receive water when transplanted. At the time of planting, a basin should be constructed around each plant to accumulate water and snow.

Research Needs

Revegetational studies have never been conducted using T3 (commercial retort system proposed to be used by SED) proposed shale. Therefore, careful studies on plant growth on T3 processed shale are needed. Some areas of research include:

1. Precise information on physical and chemical properties of T3 shale
2. Investigations to ameliorate the lack of fine material and the consequent low water holding capacity of the shale
3. Investigations on plant uptake of toxic material
4. Develop measures to prevent salt migration to surface
5. Plant establishment and growth
6. Soil and shale mixing to maximize plant growth
7. Plant colonization and succession

Two field experiments are planned that should answer the above questions. The first plot study will evaluate the processed shale as a plant growth medium (Fig. 12). Five planting mediums will be treated with three different plant establishment techniques and three different fertilizer treatments. The planting media will be shale, soil, shale with soil in trenches, shale with soil in pockets, and shale with a cover of 13 cm (5 inches) of soil.



Plant Growth Medium

1 - Shale
2 - Soil
3 - Shale with soil in trenches
4 - Shale with soil in pockets
5 - Shale under five inches of soil

Planting Treatment

1 - Drilled seed mixture
2 - Tranplanted container grown plants
3 - Combination of both

Fertilizer Treatment

1 - Nitrogen and phosphorus
2 - Retort water
3 - Unfertilized

Fig. 12. Experimental split-plot design to evaluate T3 processed shale as a plant growth medium.

The planting treatment will consist of direct seeding, transplanting container-grown plants, and a combination of both. The fertilizer treatment will be nitrogen and phosphorus, retort water only, and no fertilizer. Parameters to be measured are plant growth, root growth into shale, chemical analyses of plant tissue, and plant-water relationships.

The second study plot will evaluate plant colonization onto processed shale and pedogensis (Fig. 13). Four planting mediums consisting of shale, soil, shale with soil in pockets, and shale with a cover of 13 cm (5 inches) of soil will be treated with four planting methods. The planting methods will be seeded Russian thistle, seeded cheatgrass, transplanted container-grown plants, and no treatment. Parameters to be measured are plant succession and pedogensis processes.

MONITORING

Plant communities are dynamic. Therefore, plant cover, density and productivity change from year to year depending on environmental conditions. These parameters should be monitored yearly and correlated with environmental data such as annual precipitation. Several years of data provide an excellent baseline for comparative purposes after mining commences and post-mining reclamation.

To accomplish this, a reference area should be established for each vegetation type with potential disturbance. Plant cover, density and production should be measured each year. The reference areas should be fenced to prevent grazing and other disturbances.

The population dynamics of Duschense milkvetch should be observed for several years. Plant cover and density data would be beneficial in case

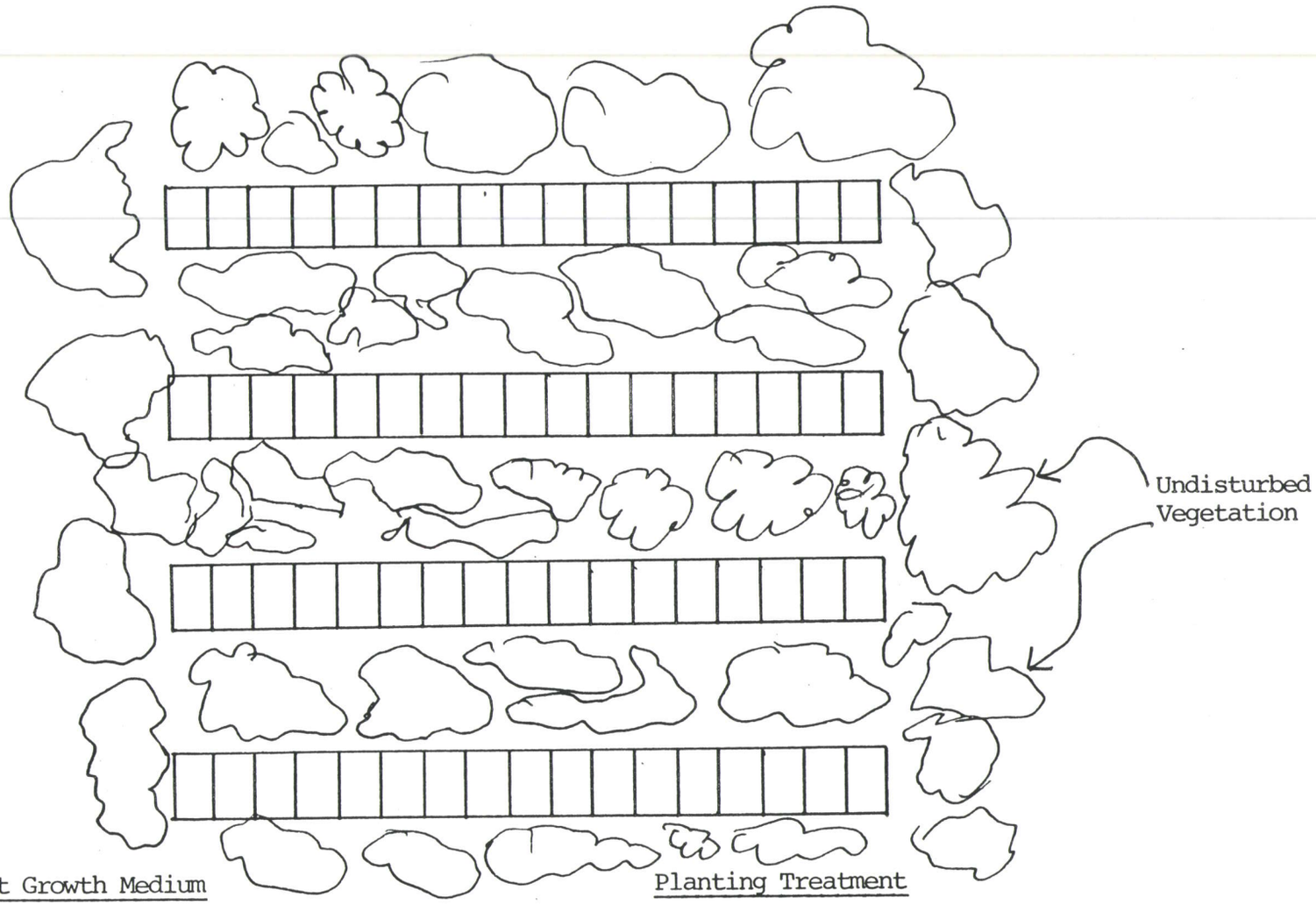


Fig.13. Experimental split-plot design to evaluate plant colonization and pedogensis of T3 processed shale.

it is reevaluated for a Category 1 threatened or endangered plant species.

The population of hookless fishhook cactus should be observed yearly. Changes in population size can then be recorded. If possible, seed should be collected to establish a population in an area with no disturbance potential.

Another concern is the revegetation of disturbed areas. The Cottonwood Wash area receives less than 25 cm (10 inches) of annual precipitation. Thus, revegetation using conventional methods, such as direct seeding, would probably not be successful. Thus, pilot models and study plots would be useful in developing successful revegetation techniques. Such study plots should be evaluated for several years.

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FAUNA

The following report is a summation of a wildlife survey on the Magic Circle Cottonwood Wash Oil Shale Project, Uintah County, Utah, for Synfuels Engineering and Development Company.

OBJECTIVES

Wildlife are surveyed on the mine permit area and a 1.6 km boundary to determine species inventory, temporal and spatial distribution, and abundance or density. Attention is paid to raptors, migratory birds, upland game birds, state protected species, threatened and endangered species, big-game and non-game species. Details collected on non-game wildlife exceed the requirements for permitting for two reasons. First, effective monitoring of impact or enhancement due to shale mining, retorting and disposal can be quantitatively determined only by using non-game wildlife since the other species occur in low numbers and with extensive dispersal patterns. Second, measuring reclamation success dependent on species other than non-game would have to be based on subjective judgements which could hinder bond release and cause SED unwarranted expenses where they are not required.

METHODS AND MATERIALS

Site visits on the Cottonwood Wash property were made in October 1981, February, April, June, July and September 1982. During October, line transects for mammals were set in six locations (Fig. 2), two in Greasewood-Sagebrush habitat referred to as Greasewood, two in Shadscale habitat, and two in Mat Saltbush habitat (see Vegetation Report for details on habi-

tats). Line transects, one kilometer in length were set according to Burnham et al. (1980). Each transect was walked for three consecutive evenings between two hours prior to sunset and one hour after sunset. All animals seen were recorded by species, number observed, perpendicular distance from the transect (in meters), behavior (feeding, drinking, running, etc.) and substrate (bare ground, shrub base, shrub canopy, etc.). All tracks and scats were also recorded for presence/absence determination. Since the number of animals observed did not meet the minimum required to calculate densities (Burnham et al. 1980), abundance was expressed as number observed per transect kilometer.

Rodent distribution and densities were determined in October. A large grid of 144 Sherman live traps, set in 12 x 12 array, 15 m between each trap, covering 2.72 ha (6.61 ac) was set in the same location as line transects (Fig. 2). Each grid was trapped for five consecutive nights. Each trap was opened and baited with rolled oats in the evening and checked and closed each morning. Each capture was identified to species, weighed to the nearest gram, aged, sexed, individually tagged for identification or recapture and released. Capture locations in the grid and physical condition (lactating, pregnant, etc.) were also recorded. Density was calculated by:

$D = n/a$, where D = density; n = number of individuals; and a = area.

During February, April, July and September, 1982, site visits to determine big game and non-game use, raptor nesting activity, upland game bird presence, prairie dog activity, and a threatened and endangered species survey were conducted. These surveys were conducted by scanning

the area with spotting scopes and binoculars, while walking through the permit area or driving a vehicle within the permit area and in a 1.6 km boundary around the permit area.

In June 1982, line transects were walked for birds, for five consecutive days, starting at sunrise and completed within three hours. The same transects were walked again for reptiles beginning three hours after sunrise and completed by 1200 (24 hr clock, MDT). Transects were located in the three habitat types (see Fig. 2) and data recorded was identical to data recorded for mammals. Raptor nesting activity was again checked and prairie dog towns were mapped and were checked for signs of black-footed ferret (Mustela nigripes) activity in September.

Nomenclature for mammals was according to Armstrong (1972), for birds according to Behle and Perry (1975a) and the new AOU classification (Eisenmann et al. 1982), and for reptiles and amphibians according to Stebbins (1966). All data were computerized and subjected to several quality control programs to reduce computational errors. Means of paired sampling sites were calculated and include standard deviation.

Reptile abundance was expressed as number per kilometer. Population densities for birds were estimated using the computer program "TRANSECT" developed by the Utah Cooperative Wildlife Research Unit (Burnham et al. 1980). This method fits a curve generated by a Fourier Series of the distribution of perpendicular distances for all sightings of a species in each habitat and calculates a density based on this detectability curve. Thirty to 40 sightings were usually required to construct a reliable distribution. When fewer sightings were available, which was often the case in these sparsely populated habitats, species with similar detectabilities

(e.g., all sparrows) were combined for analysis. Species densities were then estimated by partitioning the "detectability group" density among species based on proportional representation. Species richness was a summation of individual species. Species diversity, H', was calculated according to Shannon (1948). Similarities were calculated according to Bray-Curtis coefficient (Motyka et al. 1950). Three types of weighing factors were used: (1) abundance; (2) biomass; and (3) species composition. In order to view a habitat's importance to wildlife, similarity indices for the above factors were averaged for three vertebrate groups: reptiles, birds and rodents.

AQUATIC WILDLIFE

No flowing streams are located on the Cottonwood Wash property. The main drainage is Cottonwood Wash which flows intermittantly and empties into the White River north of the property. The wash serves as a corridor for terrestrial wildlife. Five ponds are located on the property in Sections 16, 18, 24, 29 and 31. All but one is charged by intermittant surface flows. One pond in the northeast corner of the property (Sec. 16) is charged by flows from an abandoned natural gas well.

Green-winged teal (Anas crecca) used a stock pond adjacent to the mine permit area (north of Sec. 18). Although no nest was found, the teal are ranked as a summer resident due to consistent presence. Other waterfowl use this pond during migration; however, the pond's importance to waterfowl is minimal due to the nearby wetlands along the Green River, i.e., the Ouray National Wildlife Refuge.

TERRESTRIAL WILDLIFE

Raptors

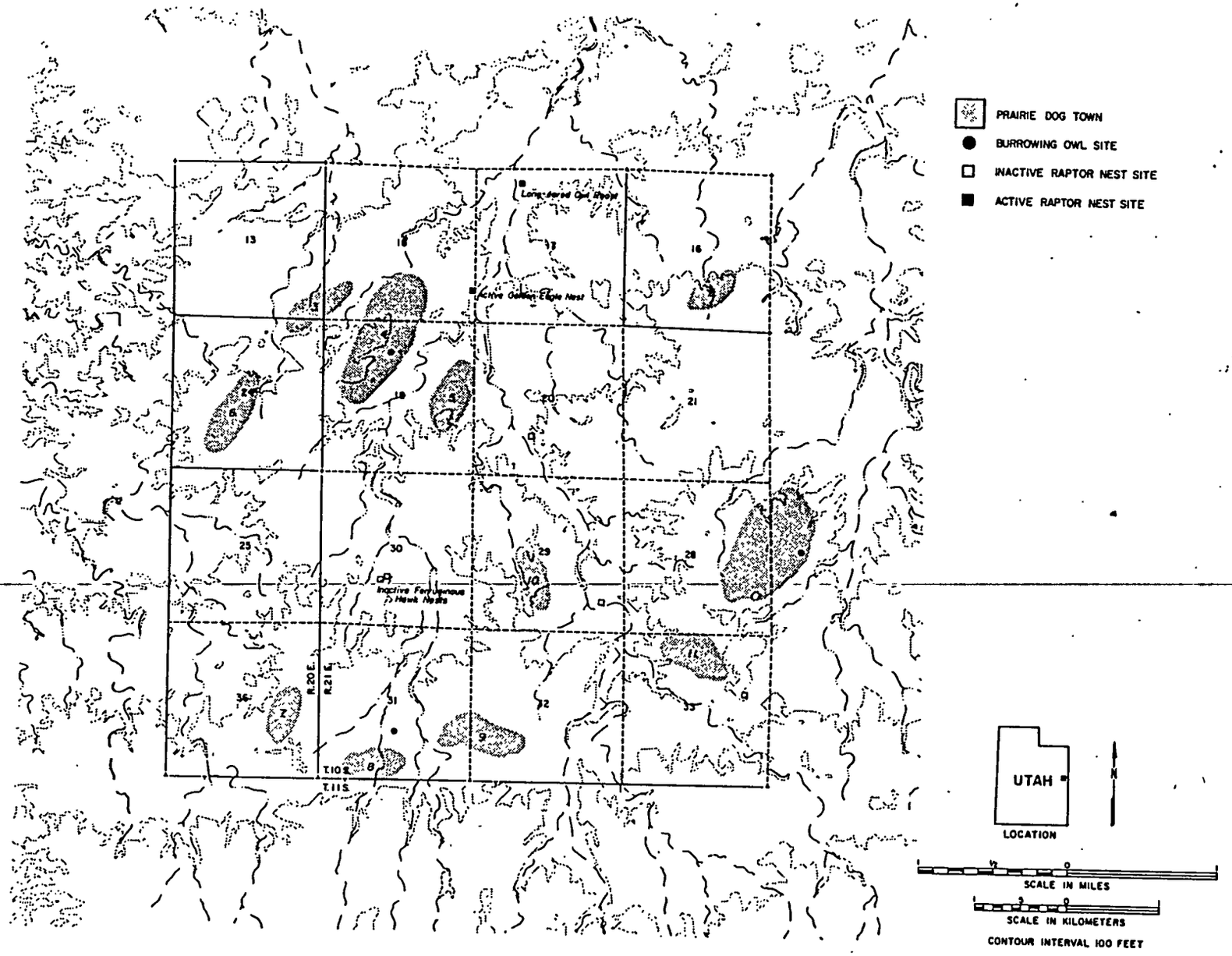
Nine raptor species occurred on the mine permit area. Three of these species nested on the tracts in 1982: golden eagle (Aquila chrysaetos); burrowing owl (Athene cunicularia); and American kestrel (Falco sparverius).

The golden eagle nest produced one young. The nest is located in Sec. 18, SE¼ (see Fig. 14) with an eastern exposure in a sandstone cliff above Cottonwood Wash. Although the nest is located within 1.6 km of the plant site, no activity or roads will hamper the eagle's use of the site in the future.

Long-eared owls roost in the solitary Fremont cottonwood (Populus fremontii) found in Cottonwood Wash (Sec. 17, NW¼)(see Fig. 2). Five owls, apparently a family group, were encountered at this location in October 1981 and four in September 1982. The owls did not use the tree for nesting. Most likely they nested along the White River.

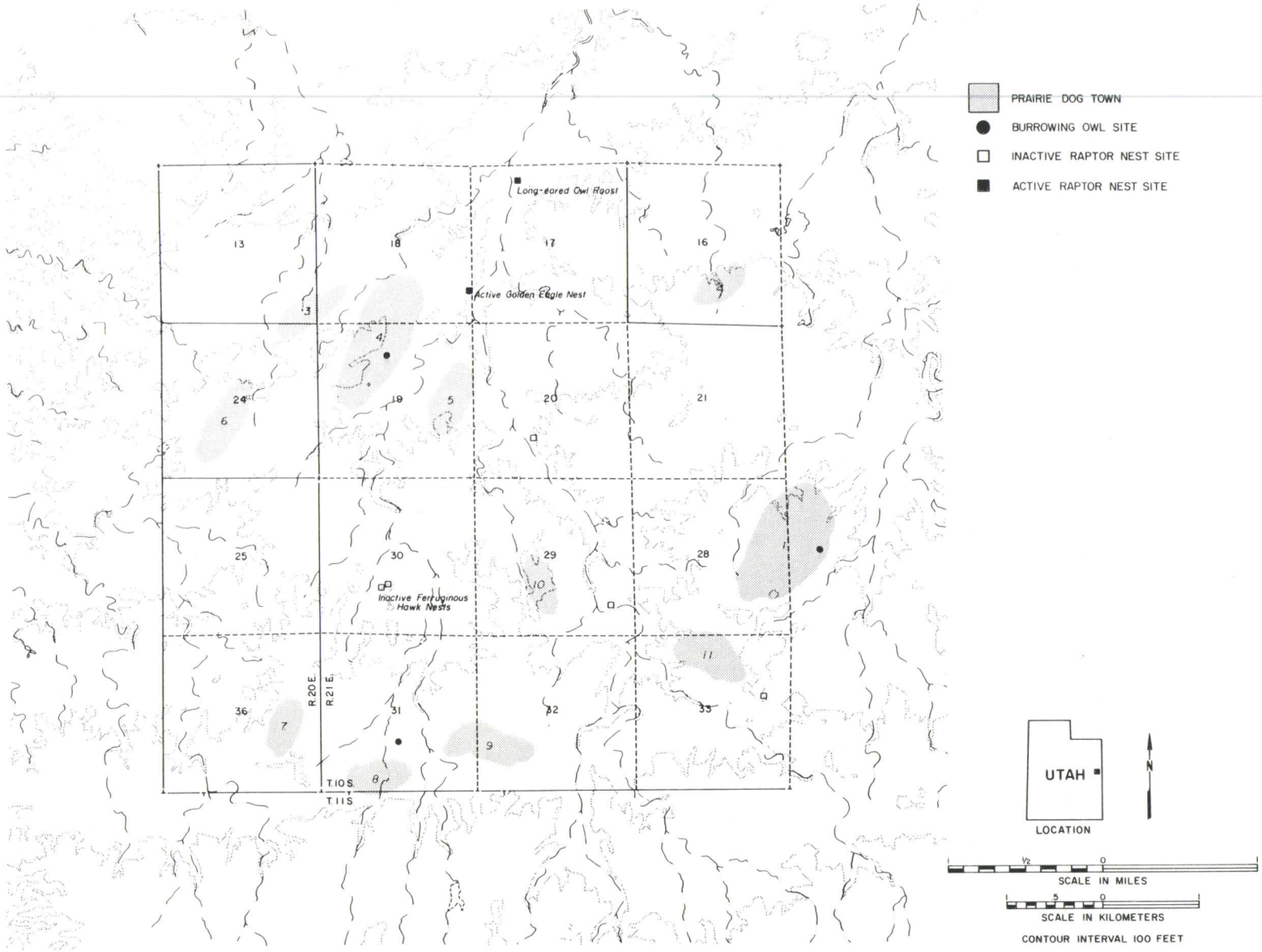
Burrowing owls were encountered in three prairie dog towns, #1, 4 and 8 (see Fig. 14). Although all are considered nestors, this was not confirmed.

No attempts were made to locate the nest sites of the two, or perhaps three, pair of American kestrels in the permit area. Nor could a nesting site for one prairie falcon (Falco mexicanus) be located on the permit area, if in fact a site exists. One pair of northern harriers (Circus cyaneus) occurred on and near the permit area, most often observed near a pond north of Sec. 18.



RAPTOR NESTS AND PRAIRIE DOG TOWNS

Fig. 14. Location of raptor nests and prairie dog towns on the Cottonwood Wash project area.



RAPTOR NESTS AND PRAIRIE DOG TOWNS

Ferruginous hawks (Buteo regalis) were observed in the permit area in October 1981 and two inactive nests were found in Sec. 30. No nesting occurred in 1982. Since the nests are in the shale disposal area, they will eventually be lost. However, there are numerous other potential nest sites in the permit area and in adjacent areas.

Three other raptors observed in the permit area were red-tailed hawks (Buteo jamaicensis), turkey vultures (Cathartes aura) and loggerhead shrikes (Lanius ludovicianus). The shrike is a permanent resident and the other two are considered transients, i.e., residing in an adjacent area and occasionally foraging in the permit area.

Expected raptors (Behle and Perry 1975b; Vander Wall and Steele 1982) which would be considered transients are sharp-shinned hawks (Accipiter striatus) and short-horned owls (Asio flammeus). An expected winter resident is the rough-legged hawk (Buteo lagopus). None of the three were observed on or near the permit area.

Migratory Birds of High Federal Interest

Of the 22 migratory species of high federal interest, four occurred within the mine's boundary - golden eagle, prairie falcon, ferruginous hawk and burrowing owl. These species are treated under RAPTORS. The bald eagle (Haliaeetus leucocephalus) winters along the White and Green Rivers and might also be found along Hill and Willow Creeks. These eagles will forage in desert shrub habitats along a river's corridor; however, the distance of the tracts from suitable riparian habitat precludes their presence.

Eight other migratory birds, which do or have occurred near the permit area (50 km radius)(Behle and Perry 1975b; Vander Wall and Steele 1982), are peregrine falcon (Falco peregrinus), merlin (Falco columbaris), Cooper's hawks (Accipiter cooperii), osprey (Pandion haliaeetus), great blue heron (Ardea herodias), sandhill crane (Grus canadensis), western bluebird (Sialia mexicana), and Scott's oriole (Icterus parisorum). The presence of any one of these species is highly unlikely, since their habitat requirements, either during migration or as residents, are not met in or near (1.6 km boundary) the mine permit area.

Upland Game Birds

Of the nine upland game birds of concern, only two species might be found on or near the tracts - chukar (Chukar alectoris) and sage grouse (Centrocercus urophasianus). Neither were observed nor would any substantial populations be expected, due to lack of suitable habitat. Both are considered transients.

State Protected Species

Among the mammals of the State Protected Species, six are potential but not expected. Classified as Endangered, the black-footed ferret's (Mustela nigripes) presence in the Uinta Basin is unverified. The ferret's usual food resource is prairie dogs. Where prairie dogs are present, three conditions were recommended by Hillman et al. (1979) to meet the ferret's minimal habitat requirements: (1) at least eight prairie dog towns per township; (2) each town should be at least 12 ha in size; and (3) two or more towns should exceed 40 ha.

Since ferrets are nocturnal and difficult to observe, three indicators of their presence are tracks, scats, and trenching. Ferret

tracks are not a reliable indicator since they would be obscured by prairie dog activity; however, early morning inspection prior to prairie dog activity is useful (Fortenberry 1972). Ferret scats are usually unreliable since they are seldom found above ground (Hillman 1968). Signs of trenching and dirt scattered in all directions around a burrow is the most reliable indicator of ferret presence. However, there are two problems (Fortenberry 1972): (1) prairie dogs also dig trenches at the burrow entrance which seldom extends beyond the mound of dirt around the burrow, even though ferret trenches do extend beyond the mound; and (2) due to the nocturnal activity of ferrets, a trench can be destroyed in the morning by prairie dog activity.

Since white-tailed prairie dogs (Cynomys leucurus) are found in the permit area, and the number and area of towns meets minimal conditions per Hillman et al. (1979)(Table 26) prairie dog towns 4, 7, 8 and 9 (see Fig. 14 were closely inspected due to their eventual disturbance by development.

White-tailed prairie dog town #4 contained a high concentration of burrows, compared to towns #7 and 8, and town #9 contained few burrows and was considered of marginal value (Table 26). White-tails form a loose colony when compared to black-tailed prairie dogs (Cynomys ludovicianus). Colonies are usually divided into two or more wards with black-tail wards supporting hundreds to thousands of adults and yearlings and white-tail wards, no more than 100 adults and yearlings (Hoogland 1981). As Hoogland points out, density in white-tail colonies is significantly lower than density found in black-tail colonies. These data suggest that conditions recommending ferret presence based on black-tails (Hillman et al. 1979) should be doubled, if not tripled, for white-tails.

Table 26. Size of prairie dog towns on the Cottonwood Wash Project, Uintah County, Utah, 1982. NC - not counted.

Prairie Dog Town	Size, hectares	Number of Burrows	Ferret Sign
1	82.1	NC	-
2	14.8	NC	-
3	19.3	NC	-
4	72.6	400	No
5	24.8	NC	-
6	29.1	NC	-
7	16.1	43	No
8	18.3	21	No
9	26.9	NC	-
10	15.7	NC	-
11	25.5	NC	-

No ferret signs were found in any dog town nor are ferrets expected.

Classified as Under Investigation, the bobcat (Lynx rufus) occurs in the Uinta Basin and is considered a transient in the mine permit area due to the lack of suitable habitat.

Classified as Limited, there are three species which occur in the basin and a fourth which may be present. Although they are not expected on the mine permit area, the following information may be useful to DOGM. The desert shrew (Notiosorex crawfordi) is supposedly not found in Utah

(Durrant 1952; Hall and Kelson 1959) and extends only into a small section of southwestern Colorado (Armstrong 1972). However, a specimen taken by Caire and Finley (1977) in Colorado and the similarity in habitat found in the Uinta Basin led the authors to suggest the shrews' presence along the White and Green Rivers.

The spotted bat (Euderma maculatum) is considered a potential species in the Uinta Basin (Olsen 1973; Ranck 1961). Its presence was recently confirmed in Dinosaur National Monument (personal communication, R.B. Finley, Jr., USFWS, Ft. Collins, CO 1982). None were captured (Grant, manuscript in prep.) in the basin during five years of netting (1976-1980); however, the spotted bat's ability to avoid nets (Barbour and Davis 1969) suggests that few, if any, would be netted.

The thirteen-lined ground squirrel (Spermophilus tridecemlineatus) is expected in the basin in desert shrub habitat north of the White River, east of the Green River, and south of Blue Mountain and the Yampa Plateau (Durrant 1952). An individual was observed by Grant and P.E. Kung (personal observation 1976) in this area and their presence was confirmed in the wildlife survey but not reported in the Moon Lake Power Plant EIS (BLM 1981).

The Wyoming pocket mouse (Perognathus fasciatus), also known as the olive-backed pocket mouse, was found north of the White River by Olsen (1973) and south of the White River by Perry (1975). Through eight years of trapping rodents south of the White River near the area where Perry (1975) collected his specimen, none of these pocket mice were captured (Grant, manuscript in prep.).

Classified as Status Questioned, raccoon (Procyon lator) occur along the White River (Grant, manuscript in prep.), and in the Ashley Creek Basin near Vernal, Utah (Grant, personal observation 1976). None of these mammals were found or are expected in the permit area.

Eleven species of birds under the State Protected Species are possible visitors on the mine permit area. Three species are classified as Endangered. Although a pair of peregrine falcons are currently known to nest in Dinosaur National Monument and these falcons were observed along and near the White River south of Bonanza, Utah in 1975 (Vander Wall and Steele 1982), the mine permit area does not meet the habitat or food resource requirements for this falcon (CDOW 1978).

The bald eagle is treated under MIGRATORY BIRDS.

The whooping crane (Grus americanus) occurs in the basin accompanying sandhill cranes during migration between Gray's Lake National Wildlife Refuge, Idaho and New Mexico. One was recently reported at Ouray National Wildlife Refuge along the Green River. None are expected on the mine permit area due to lack of suitable habitat.

The sandhill crane is classified as Limited. Large flocks migrate across the basin in April and October and have been encountered along the White River (Vander Wall and Steele 1982). The lack of riparian habitat on the mine permit area precludes their presence.

The lack of riparian habitat also eliminates the presence of four species classified as Status Questioned: great blue heron, merlin, belted kingfisher (Megoceryle alcyon) and western bluebird. The heron is a summer resident along the White River, the kingfisher is a permanent resident, and the merlin and bluebirds are migrants (Vander Wall and

Steele 1982). A fifth species, the yellow-billed cuckoo (Coccyzus americanus) was previously reported on the mine permit area. None were found in 1981 or 1982, nor does the habitat available suggest that cuckoo would ever be present. It is, however, a summer resident at low density along the White River (Vander Wall and Steele 1982). The grasshopper sparrow (Ammodramus savannerum) was observed near Vernal, Utah in 1976 (Grant, personal observation) but is an unconfirmed sighting.

Mountain bluebirds (Sialia curricoides) are expected as spring migrants. Their nesting habitat in the Uinta Basin is in riparian and juniper habitats (Vander Wall and Steele 1982).

Only one reptile, the Utah milk snake (Lampropeltis triangulum gentalis) that is classified as Limited, occurs in the Uinta Basin (Tanner 1947; VTN 1977). It might be found in the permit area. One specimen was encountered near a stock pond north of Bonanza, Utah in 1976 (VTN 1977) which suggests that it may be present at stock ponds in the permit area. None were found in the permit area.

Federally Listed Threatened and Endangered Species

Of the four terrestrial species listed as threatened and endangered (Federal Register 1973), none occur on the tracts nor are any expected. See STATE PROTECTED SPECIES for information on the black-footed ferret, peregrine falcon, and whooping crane. Bald eagles are treated under MIGRATORY BIRDS.

Big Game

Two big game species occur in the mine permit area - pronghorn (Antilocapra americanus) and mule deer (Odocoileus hemionus). The largest group of pronghorn observed was a mixed group of five does and subadults in the southeastern sector of the permit area. One pronghorn buck was seen consistently in the northeast sector of the permit area. The permit area appears to be marginal habitat for pronghorn. Only two mule deer were encountered, one in February and one in July, both in or adjacent to greasewood-covered draws. The importance of the permit area for fawning, winter and summer range appears minimal for both species.

Non-Game Vertebrates - Amphibians, Reptiles, Birds and Mammals

Amphibians and Reptiles

Two desert toads are expected at the ponds on the mine permit area: Woodhouse's toad (Bufo woodhouseii) in the family Bufonidae and Great Basin spadefoot (Scopiopus intermontanus) in the family Paleobatidae. Intermittant water at stock ponds in the Uinta Basin support both these species at low abundance (Grant 1982). Another toad, which may be found at the ponds, is apparently expanding its distribution north of the Colorado River - the red-spotted toad (Bufo punctatus) - recently found in Asphalt Wash in 1980 (Grant 1982).

Nine species of reptiles occur on the mine permit area (Table 27). Greasewood and Shadscale habitats support the highest lizard abundance, yet Mat Saltbush supports the highest lizard diversity. Greasewood is dominated by the western whiptail (Cnemidophorus tigris), while the whiptail shares dominance with the sagebrush lizard (Sceloporus graciosus)

Table 27. Abundance during June, habitat distribution and residency and guild status of reptiles on the Magic Circle Cottonwood Wash Project, Uintah County, Utah for 1981-1982. Expected reptiles are also included. (X) denotes presence; (-) denotes no sightings.

Guild	PERMANENT RESIDENTS (11 spp)	ABUNDANCE BY HABITAT Number/Kilometer ± S.D. Greasewood/Sagebrush	Shadscale	Mat Saltbush
I	Sagebrush Lizard *Sceloporus graciosus*	X	1.5±1.7	0.3±0
I	Eastern Fence Lizard *Sceloporus undulatus*	X	X	-
I	Side-blotched Lizard *Uta stansburiana*	0.3	-	-
I	Tree Lizard *Urosaurus ornatus*	X	-	-
I	Short-horned Lizard *Phrynosoma douglassi*	0.3	0.2±0.2	0.8±0.7
I	Western Whiptail *Cnemidophorus tigris*	3.3	2.4±0.5	0.7±0
C	Striped Whipsnake *Masticophis taeniatus*	X	X	X
C	Gopher Snake *Pituophis melanoleucus*	X	X	X
C	Western Rattlesnake *Crotalus viridus*	X	X	X
	Overall Abundance	3.9	4.1	1.8
	Overall Species	9	7	6
	Species Diversity, H'	0.54	0.83	1.03

Guild

I = Insectivore
C = Carnivore

in Shadscale and with the short-horned lizard (Phrynosoma douglassi) in Mat Saltbush. The other lizards, all of which are insectivores, occur at low abundance near or on vertical sandstone outcrops. The three species of snakes, which are carnivores, all occur at low abundance with only individuals of each species encountered during all site visits.

Birds

Forty-two species of birds occurred on the mine permit area in 1981-1982. An additional 29 species are listed as expected (Table [28]). Of the 42 bird species found in 1981-1982, eight are permanent residents, 13 are summer residents, one is a winter resident, and 20 are transients (residing in other habitats near the mine permit area) or migrants. Of the 29 expected species, five species would most likely be summer residents, six would be winter residents, and 18 would be transients or migrants.

Avian summer residents comprised the highest June densities and the transients, the lowest. Surprisingly, Shadscale supported the highest avian density while Greasewood and Mat Saltbush were equivalent. Species richness was highest in Greasewood, due mainly to the transient birds from Riparian habitats along the White River that occasionally foraged in Cottonwood Wash. Avian species diversity was highest in both Greasewood and Shadscale and lowest in Mat Saltbush.

The granivorous birds were the dominant guild in Shadscale and Mat Saltbush and shared dominance with the raptor guild in Greasewood in terms of density (Table 29). The dominant guild in terms of species richness was the insectivores due to the Riparian species foraging in Cottonwood Wash. Guild diversity, like species diversity, was again highest in Greasewood.

Table 28. Density during June, habitat distribution and residency and guild status of avifauna on the Magic Circle Cottonwood Wash Project, Uintah County, Utah for 1981-1982. Expected avifauna are also included. (X) denotes presence; (-) denotes no sightings.

Guild		DENSITY BY HABITATS Number/Hectare ± SD			
	PERMANENT RESIDENTS (8 spp)	Greasewood/ Sagebrush	Shadscale	Mat Saltbush	Ponds
R	Golden Eagle *Aquila chrysaetos*	0.03±0.01	X	<0.01	X
R	Northern Harrier *Circus cyaneus*	0.01±0.01	X	X	X
R	Prairie Falcon *Falco mexicanus*	X	X	X	X
R	Burrowing Owl *Athene cunicularia*	-	X	X	X
G	Horned Lark *Eremophilus alpestris*	X	2.5±1.6	2.3±0.6	-
O	Black-billed Magpie *Pica pica*	0.2±0.4	-	-	X
GI	Rock Wren *Salpinctes obsoletus*	<0.01	X	X	-
R	Loggerhead Shrike *Lanius ludovicianus*	1.2±0.6	X	0.09±0.13	X
	Σ-Density	1.44	2.5	2.39	-
	Σ-Species	7	7	7	6
	SUMMER RESIDENTS (13 spp)				
A	Green-winged Teal *Anas crecca*	-	-	-	X

Table 28. Continued

Guild	SUMMER RESIDENTS (13 spp)	DENSITY BY HABITATS Number/Hectare ± SD			
		Greasewood/ Sagebrush	Shadscale	Mat Saltbush	Ponds
R	American Kestrel *Falco sparverius*	X	X	0.01±0.01	X
A	Killdeer *Charadrius vociferus*	0.02±0.02	X	-	X
G	Mourning Dove *Zenaida macroura*	0.8±0	0.2±0.3	X	X
AHI	Say's Phoebe *Sayornis saya*	X	X	X	X
GI	Sage Thrasher *Oreoscoptes montanus*	X	0.4±0.2	0.2±0.06	-
GI	Bendire's Thrasher *Toxostoma bendirei*	0.04±0.06	-	-	-
G	Black-throated Sparrow *Amphispiza bilineata*	0.06±0.08	0.1±0.2	-	-
G	Sage Sparrow *Amphispiza belli*	0.06±0.08	2.0±0.6	-	-
G	Lark Sparrow *Chondestes grammacus*	0.3±0.2	0.3±0.3	0.2±0.08	X
G	Brewer's Sparrow *Spizella breweri*	0.06±0.08	1.1±0.2	-	X
G	Chipping Sparrow *Spizella passerina*	-	0.06±0.08	-	-
O	Red-winged Blackbird *Agelaius phoeniceus*	0.03±0.05	-	-	X
	Emberizidae	0.1±0.2	0.6±0.4	0.1±0.2	
	Passerines	0.1±0.2	0.06±0.08	-	-
	Σ-Density	1.57	4.82	0.51	
	Σ-Species	11	10	5	7

Table 28. Continued.

Guild		DENSITY BY HABITATS Number/Hectare ± SD			
		Greasewood/ Sagebrush	Shadscale	Mat Saltbush	Ponds
	WINTER RESIDENTS (1 spp)				
R	Long-eared Owl *Asio otus*	X	-	-	X
	TRANSIENTS & MIGRANTS (20 spp)				
A	Northern Shoveler *Anas clypeata*				X
A	Lesser Scaup *Aythya affinis*				X
R	Turkey Vulture *Catharte aura*	X	X	X	X
R	Red-tailed Hawk *Buteo jamaicensis*	X	X	X	X
R	Ferruginous Hawk *Buteo regalis*	-	X	X	X
A	Wilson's Phalarope *Steganopus tricolor*				X
ACI	White-throated Swift *Aeronautes saxatalis*	X	-	-	X
GI	Northern Flicker *Colaptes auratus*	X	-	-	X
ACI	Tree Swallow *Tachycineta bicolor*	X	-	-	X
ACI	Violet-green Swallow *Tachycineta thalassina*	0.02±0.02	-	-	X
ACI	Northern Rough-winged Swallow *Stelgidopteryx serripennis*	X	-	-	X
ACI	Cliff Swallow *Hirundo phyrrhonota*	0.02±0.02	-	-	X

Table 28. Continued.

Guild	TRANSIENTS & MIGRANTS (20 spp)	DENSITY BY HABITATS Number/Hectare ± SD Greasewood/ Sagebrush	Shadscale	Mat Saltbush	Ponds
ACI	Barn Swallow *Hirundo rustica*	0.02±0.02	0.03±0.05	-	X
O	Common Raven *Corvus corax*	X	X	X	X
FI	Black-capped Chickadee *Parus atricapillus*	X	-	-	X
BI	Bewick's Wren *Thryomanes bewickii*	X	-	-	X
FI	Western Tanager *Piranga ludoviciana*	X	-	-	X
G	Vesper Sparrow *Pooecetes gramineus*	-	X	-	-
GI	Western Meadowlark *Sturnella neglecta*	X	-	-	X
G	American Goldfinch *Carduelis tristis*	X	-	-	X
	Σ-Density	0.06	0.03		
	Σ-Species	15	6	4	19
	Overall Density	3.07	7.35	2.9	
	Overall Species	33	23	16	32
	Species Diversity, H'	1.84	1.79	0.81	

EXPECTED AVIFAUNA	Residency Status	HABITAT TYPE Greasewood/ Sagebrush	Shadscale	Mat Saltbush	Pond
Mallard *Anas platyrhynchos*	M	-	-	-	X
Gadwall *Anas strepera*	M	-	-	-	X
Pintail *Anas acuta*	M	-	-	-	X

Table 28. Continued.

EXPECTED AVIFAUNA	Residency Status	HABITAT TYPE: Greasewood/ Sagebrush	Shadscale	Mat Saltbush	Pond
Cinnamon Teal *Anas cyanoptera*	M	-	-	-	X
American Wigeon *Anas americana*	M	-	-	-	X
Sharp-shinned Hawk *Accipiter striatus*	T	X	X	-	-
Rough-legged Hawk *Buteo lagopus*	W	X	X	X	-
Sage Grouse *Centrocercus uruphasianus*	T	X	X	-	-
Chukar *Alectoris chukar*	T	-	X	X	-
Yellow-billed Cuckoo *Coccyzus americanus*	T	-	-	-	X
Short-eared Owl *Asio flammeus*	T	X	X	X	-
Common Nighthawk *Chordeiles minor*	T	X	X	X	X
Broad-tailed Hummingbird *Selaspherus platycercus*	S	X	X	-	X
Western Kingbird *Tyrannus verticalis*	S	X	X	-	X
Common Bushtit *Psaltriparus minimus*	W	X	X	-	-
Mockingbird *Mimus polyglottis*	S	X	X	-	-
American Robin *Turdus migratorius*	M	X	-	-	X
Mountain Bluebird *Siala currucoides*	M	X	X	-	-
Northern Shrike *Lanius excubitor*	W	X	X	-	-
Starling *Sturnus vulgaris*	T	X	X	-	-
Yellow-rumped Warbler *Dendroica coronata*	M	X	-	-	X
Common Yellowthroat *Geothlypis trichas*	T	-	-	-	X
Brewer's Blackbird *Euphagus cyanocephalus*	T	X	X	-	X
Rosy Finch *Leucosticte arctoa*	W	X	X	X	-
Rufous-sided Towhee *Pipilo erythrophthalmus*	S	X	-	-	X

Table 28. Continued.

EXPECTED POTENTIAL	Residency Status	HABITAT TYPE: Greasewood/ Sagebrush	Shadscale	Mat Saltbush	Ponds
Dark-eyed Junco *Junco hyemalis*	W	X	X	-	-
Tree Sparrow *Spizella arborea*	W	X	-	-	-
White-crowned Sparrow *Zonotrichia leucophrys*	M	X	-	-	X
Song Sparrow *Melospiza melodia*	S	X	-	-	X

Key

Guilds

A = Aquatic spp
R = Raptor
G = Granivore
O = Omnivore
GI = Ground Insectivore
FI = Foliage Insectivore
BI = Bark Insectivore
AHI = Air Hawking Insectivore
ACI = Air Cruising Insectivore

Residency Status

S = Summer Resident

W = Winter Resident

M = Migrant, Spring and Fall

T = Transient, has Summer, Winter or Permanent status in other parts of Uinta Basin

Table 29. Avian feeding guild density, habitat distribution, species richness and diversity on the Magic Circle Cottonwood Wash Project, Uintah County, Utah, 1981-1982.

Feeding Guild	Number of Species	DENSITY Number/20 hectare HABITAT TYPE		
		Greasewood	Shadscale	Mat Saltbush
Aquatic spp.	2	0.02	0	0
Raptors	8	1.24	0	0.10
Granivores	9	1.28	6.29	2.50
Omnivores	3	0.29	0	0
Insectivores	15	0.09	0.48	0.22
Guild Diversity, H'		1.09	0.26	0.43

Among the non-game birds, seven species were dominant in terms of density. In the permanent resident category, horned larks (Eremophilus alpestris), a granivore, were at densities of 2 birds/ha in Shadscale and Mat Saltbush. The latter habitat appears to be preferred using standard deviation as the criterion. Loggerhead shrikes (Lanius ludovicianus), a raptor, occurred at 1 bird/ha in Greasewood. The shrikes were nesting in the tall greasewood and the high density was due to parents and recent fledglings at the nest sites.

In the summer resident category, mourning doves (Zenaida macroura), a granivore, occurred at highest density in Greasewood. The other granivorous summer residents which occurred at high densities in Shadscale were the sage sparrow (Amphispiza belli), Brewer's sparrow (Spizella breweri), and lark

sparrow (Chondestes grammacus). Lark sparrows were the only granivore to occur at equivalent density in all habitat types. The only insectivorous summer resident to occur at high density was the sage thrasher (Oreoscoptes montanus) in Shadscale and Mat Saltbush.

One summer resident was a surprising find, the Bendire's thrasher (Toxostoma bendirei), which is considered a rare permanent resident in southern Utah with few observations in northern Utah (Behle and Perry 1975a). A sighting of this species in 1976 near Bonanza, Utah by D.M. Smith (Grant 1979) and this current sighting suggest a northern expansion by this thrasher.

Mammals

There are 16 mammal species on the mine permit area and another 11 species are expected (Table 30). Greasewood supports the highest abundance and diversity. Species richness is equivalent among habitat types.

The most abundant mammals are the desert cottontail (Sylvilagus audubonii), the deer mouse (Peromyscus maniculatus), and Ord's kangaroo rat (Dipodomys ordii). Cottontails increased in abundance from fall to spring, a trend similar to that measured on the Utah Oil Shale Tracts, Ua and Ub (Grant, personal observation). Deer mice were densest in Greasewood and at lower but equivalent densities in Shadscale and Mat Saltbush. Ord's kangaroo rats were equally dense in all three habitat types. The distribution of the one granivore suggests seed availability in the soils is roughly equivalent across habitats. The high density of granivorous birds suggests that seed production in 1982 was exceptionally high. Carnivores are scarse, identified only by their tracks.

Table 30. Fall and spring abundance, fall density, habitat distribution and residency and guild status of mammals on the Magic Circle Cottonwood Wash Project, Uintah County, Utah for 1981-1982. Expected mammals are also included. (X) denotes presence; (-) denotes no sightings or sign.

Guild	PERMANENT RESIDENTS (9 spp)		ABUNDANCE BY HABITAT Number/Kilometer ± S.D. Greasewood/ Sagebrush	Shadscale	Mat Saltbush
H	Desert Cottontail	Fall	0	0	0.2±0.2
	Sylvilagus audubonii	Spring	3.5±0.7	0.7±0	0
H	White-tailed Jackrabbit		X	X	-
	Lepus townsendii				
H	Black-tailed Jackrabbit	Fall	0.3±0.4	0	0
	Lepus californicus	Spring	0.7±0	1.4±19.	0
O	White-tailed Antelope	Fall	0.2±0.2	0	0
	Squirrel	Spring	0.8±1.2	0.4±0.5	1.8±2.6
	Ammospermophilus leucurus				
O	Golden-mantled Ground Squirrel		X	X	-
	Spermophilus lateralis				
H	White-tailed Prairie Dog		-	X	X
	Cynomys leucurus				
C	Coyote		X	X	X
	Canis latrans				
C	Badger		X	X	X
	Taxidea taxus				
H	Pronghorn		X	X	X
	Antilocapra americana				
	Σ- Fall Abundance		0.5	0	0.2
	Σ- Spring Abundance		5.0	2.5	1.8
	Σ- Species		7	9	7
	Species Diversity, Fall		0.67	0	0
	Species Diversity, Spring		0.82	0.97	0

Table30. Continued.

Guild		DENSITY BY HABITAT Individuals/Hectare ± S.D. Greasewood/ Sagebrush	Shadscale	Mat Saltbush
	PERMANENT RESIDENTS (5 spp)			
O	White-tailed Antelope Squirrel *Ammospermophilus leucurus*	3.1±0.8	1.4±2.0	0.2±0.3
G	Ord's Kangaroo Rat *Dipodomys ordii*	4.0±0.5	4.4±0.6	4.8±2.0
H	Western Harvest Mouse *Reithrodontomys megalotis*	0.4±0	0.2±0.3	-
H,O	Deer Mouse *Peromyscus maniculatus*	10.3±1.6	4.0±1.6	3.3±1.6
I	Northern Grasshopper *Onychomys leucogaster*	0.6±0.2	0.2±0.3	0.4±0.5
H	Desert Woodrat *Neotoma lepida*	3.3±1.0	-	-
	Σ - Density	21.7	10.2	8.7
	Σ - Species	6	5	4
	Species Diversity	1.40	1.16	0.92
Guild				
	Overal Species	13	14	11
	Mean Diversity	1.11	1.06	0.46
	WINTER RESIDENTS (1 spp)			
H	Domestic Sheep *Ovis avies*	X	X	X
	TRANSIENTS (1 spp)			
H	Mule Deer *Odocoileus hemionus*	X	X	X

Table 30. Continued.

Guild	EXPECTED MAMMALS (11 spp)	Residency Status	Greasewood	Shadscale	Mat Saltbush	Ponds
I	California Bat *Myotis californicus*	S	X	-	-	X
I	Small-footed Bat *Myotis leibii*	S	X	-	-	X
I	Silver-haired Bat *Lasionycteris noctivagans*	M	X	-	-	X
I	Western Pipistrelle *Pipistrellus hesperus*	P	X	X	X	X
I	Hoary Bat *Lasiurus cinereus*	S	X	-	-	X
I	Pallid Bat *Antrozous pallidus*	S	X	-	-	X
G	Apache Pocket Mouse *Perognathus apache*	P	X	X	X	-
H	Brush Mouse *Peromyscus boylii*	P	X	X	-	-
C	Gray Fox *Urocyon cinercoargentus*	T	X	X	X	-
C	Striped Skunk *Mephistis mephistis*	T	X	-	-	-
C	Bobcat *Lynx rufus*	T	X	-	-	-

Guild

H = Herbivore
G = Granivore
I = Insectivore
O = Omnivore
C = Carnivore

Residency Status

P = Permanent Resident
S = Summer Resident
M = Migrant
T = Transient: Summer, Winter or Permanent Resident in other areas of the Uinta Basin

The herbivore guild is the most abundant and is concentrated in the densest habitat, Greasewood (Table 31). Omnivores represented by the white-tailed antelope squirrel (Ammospermophilus leucurus) are also at highest density in Greasewood.

HABITAT SURVEY

Within the three habitat types on the mine permit, similarity between paired sampling sites averaged nearly 70 percent in Mat Saltbush for abundance, biomass and species composition for reptiles, birds and rodents (Table 32). As vegetation complexity increased in Greasewood and Shadscale similarities between paired sampling sites decreased. The pattern of increasing structural complexity and decreasing similarity (or increasing diversity) is usually evident in comparisons of temperate versus tropical habitats. These similarities suggest that a generic designation such as desert shrub does not adequately describe the habitats which wildlife select.

Habitat similarity for birds was low in Greasewood when compared to Shadscale and to Mat Saltbush (Table 7) suggesting that Greasewood supported a different abundance, biomass and species composition, which is quite evident when comparing species in Table 3. The decrease in structural complexity in Shadscale when compared to the simple Mat Saltbush resulted in an increase in avian similarity. The reptiles and rodents demonstrated no specificity among habitats. The high similarity of reptiles and rodents among habitats suggests that these vertebrates are most indicative of habitat production rather than habitat structure.

IRREVERSIBLE IMPACTS

One raptor, the burrowing owl, a potential food resource and shelter for black-footed ferrets, and a potential nest site for ferruginous hawks

Table 31. Mammalian feeding guild abundance and density, habitat distribution and species richness on the Magic Circle Cottonwood Wash Project, Uintah County, 1981-1982.

Feeding Guild	Number of Species	ABUNDANCE/DENSITY BY HABITAT Number/Kilometer* Individuals/Hectare		
		Greasewood	Shadscale	Mat Saltbush
Herbivores	10	4.2* 14.0	2.1* 4.2	0.2* 3.3
Granivores	1	4.0	4.4	4.8
Insectivores	1	0.6	0.2	0.4
Omnivores	2	3.1	1.4	0.2
Carnivores	2	0	0	0

Table 32. Mean similarity of abundance, biomass and species composition for three vertebrate groups within and among three habitat types on the Magic Circle Cottonwood Wash Project.

Habitats	SIMILARITY INDEX Percent ± SD		
	Reptiles	Birds	Rodents
Greasewood (G)	-	58±2	53±8
Shadscale (S)	56±4	58±3	57±17
Mat Saltbush (MS)	70±4	73±14	63±2
Greasewood-Shadscale	69±19	8±5	61±12
Greasewood-Mat Saltbush	41±12	10±7	66±13
Shadscale-Mat Saltbush	49±15	50±12	68±20

will be lost due to construction of the plant site and disposal of spent shale.

ADVERSE IMPACTS

One raptor, the golden eagle, could be affected by activity. Loss of habitat for granivorous birds and a prey base for raptors will be lost during shale disposal, but replaced after revegetation. Habitat loss for big game and upland game is minimal.

MITIGATION

The golden eagle nest in Cottonwood Wash can be maintained and the eagles can successfully raise their young throughout the life of the mine. The nest and surrounding area should be avoided from February through April and approached cautiously through June.

Since the burrowing owl is a species of special interest, its nesting activities in prairie dog towns 4 and 8 and the number nesting in adjacent dog towns should be confirmed and compared. If their nesting is confirmed in towns 4 and 8, ways should be investigated to possibly relocate their nest sites. The prairie dog towns which will be disturbed should receive a more thorough investigation for ferret presence during the winter. The relocation of the ferruginous hawk nests will present no problem, based on recent successful relocations in the region.

Long-term mitigation can be accomplished by upgrading and expanding the stock ponds in the area. Upgrading the existing ponds by increasing the duration that water remains in the ponds will benefit all wildlife

through water availability and increased vegetation along the pond's banks. Combining this approach and the expected success of revegetation, the effects of oil shale mining will result in long-term wildlife enhancement rather than long-term impact.

To alleviate impacts from human activity, an educational program for employees should be instituted and non-work related travel on undisturbed habitat should be restricted.

MONITORING

The golden eagle nest should be monitored annually as should nest sites and roosts for other raptors. The Greasewood habitat in Cottonwood Wash should be monitored seasonally and annually for reptiles, birds, medium-to-large mammals, and rodents. Two additional monitoring sites, measuring the same parameters, should be located in Mat Saltbush east of the disposal pile and in Shadscale south of the disposal pile. If the ponds are restructured, they should be monitored for waterfowl and big game use. Following four years of consistent seasonal monitoring, the need for continued consistency can be determined from the degree of variability in population dynamics through four years. If the annual variability is low, monitoring can be reduced accordingly.

The sedimentation ponds should be monitored for toxins and for use by waterfowl, shorebirds and big game. Either deer mice or large invertebrates, such as grasshoppers, should be collected prior to mining activity and tested for heavy metal content. During mining, heavy metal tests should be repeated on a 2 to 4 year cycle.

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